SCOTTS® GUIDE TO THE IDENTIFICATION OF TURFGRASS DISEASES and INSECTS

Slime mold

Mole cricket

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Text and illustrations by JIM CONVERSE

O.M. SCOTT & SONS COMPANY

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Foreword

Scotts "Guide to the Identification of Turfgrass Diseases and Insects" has been prepared with the intent of serving as a helpful aid for those who have a strong interest in turf. It is intended to be a guide and not an all inclusive technical publication. The subject of turfgrass diseases is highly complex and a proficient knowledge requires years of structured study and observation. Very few laymen ever gain more than a very rudimentary understanding. The same is certainly true with the study of turfgrass insects.

An explanation of complex subjects generally defies the use of simple terms. To those pathologists and entomologists who are experts in the turfgrass field, we ask your indulgence for the liberties we may have taken. This guide is merely an effort to make two very difficult subjects more understandable for those of us who have a deep and inquisitive interest.

Turfgrass diseases

Introduction to Turfgrass Diseases

In nature all living things are subject to disorders and turfgrasses are no exception. Through careful selection and breeding, scientists have developed exceptional grasses with remarkable degrees of disease resistance. And though they are greatly improved, no grass has even approached a level of complete disease immunity. We can select and plant the best of these grasses, but ultimately the strongest weapon against disease is always good turfgrass management:

The subject of good turfgrass management often conjures a picture of mystic skills and abilities that only a few can ever attain. In most instances, good turfgrass management means simply using sound judgment in helping the turf perform at its vigorous best—not just for a few weeks, but season after season and year after year. Mostly it means avoiding imbalances, or excesses and creating the most positive environment for turfgrass growth. In order for this to happen, we need to have a good understanding of the turf we care for, whether it be a tiny lawn, or a great expanse like a golf course.

Golf course superintendents know that greens and fairways may be similar in appearance, but in reality no two are even remotely alike. All turf areas are composed of many tiny worlds, or micro-environments and how each of these little worlds performs determines the overall quality of the turf. On the golf course, it is not uncommon to find hills and humps which are in constant need of moisture to avoid stress. At the same time,

adjoining valleys and depressions may be in danger of stress from too much moisture. Some turf on the course can suffer from poor air circulation and it's not impossible to find nearby areas which are overexposed to the sun and the wind. Recognizing and correcting these imbalances wherever possible can only improve overall turf performance and decrease the possibility for disease. But, all too often the superintendent must learn to live with many of these adversities. If there is a secret in good turf management, it is calling on skills and judgment to make turf perform at its best under these circumstances.

Even though the home lawn is much smaller than the golf course, it too is composed of many small worlds or environments. If we acknowledge this, we can do much to make the total turf area as healthy and productive as possible. Trees can be trimmed to improve air circulation. Occasionally, conditions such as poor drainage can be corrected without going into a major project. We can keep the turf healthy by fertilizing properly, but certainly never excessively. We can relieve the stress of hot, dry weather by watering adequately, while making certain that we never keep the grass continuously wet and soggy. Where imbalances exist that cannot be altered, we can do as the golf course superintendent and call on our best judgment to do the right thing at the right time. If there are impossible situations in the turf environment, we should have the wisdom to acknowledge their presence and probable consequences. The first and most important step in avoiding turf disease is to keep the turf as healthy and vigorous as possible.

The professional turf manager continually expends his sharpest knowledge and effort to make certain his turf is always at peak performance. Healthy turf not only has a pleasing appearance, but the natural stamina to resist and survive unusual disorders. But, in spite of all his good efforts, the professional knows that there are certain times when his turf will be susceptible to disease. All turfgrass diseases become infectious and destructive within fairly predictable ranges of temperature and moisture. In each section of the country, certain diseases are naturally adaptable and most likely to occur. It is important for anyone involved in the maintenance of good turf to know which diseases are potential problems in his area. It is equally important to have a good understanding of conditions which are necessary for each to become active. Anticipation is a key component in disease prevention.

By learning all that we can about turfgrass diseases in our part of the country, we can follow recommended practices which decrease the potential for infection. Further study inevitably leads to a deeper knowledge of prevention and control of certain diseases through the use of fungicides.

Although each disease has its own characteristics and mode of action, identification beyond initial infection can be quite difficult. The pathogens that cause infectious turf diseases act like wolves and where one disease strikes another often follows. For this reason, exact identification for the purpose of control often requires microscopic analysis by a trained pathologist.

In most turf areas, disease occurs infrequently, but where imbalance and excesses are found, infection is more than probable. Fertilizing beyond recommended practices may lead to a temporary increased greening of turf, but more often than not it is an open invitation to disease. The same can be said for moisture. Proper watering is essential for healthy, vigorous growth. Turf may tolerate excessive water for some time, but sooner or later it literally explodes with some form of disease. If these two excesses are joined together, we are faced with a truly intolerable situation.

The ability to anticipate, identify and react to turfgrass diseases is an essential part of good turf management. But following the basics of good turf management is the most important step in prevention. The desire to keep grass green and beautiful should not be frustrated by the thought of turfgrass disease.

The possibility for infection by various turfgrass diseases is fairly predictable from season to season. For this reason, the diseases in this publication are listed by the season in which they are most likely to occur. Even though this seems to be a logical sequence, some diseases are capable of becoming active through several seasons and over a wide range of conditions. Understanding the range for each disease is the first step in accurate identification.

The Disease Organisms

In the broadest meaning, a turfgrass disease is caused by any condition which interferes with the normal state, or function of the grass plant. This can apply to a wide variety of disorders. In most instances, people associated with turf narrow the focus of the true meaning and turf disease becomes more specifically infectious disease.

Most infectious turfgrass diseases are caused by microscopic fungi. Fungi are simply very tiny forms of plant life that lack stems, leaves, roots, flowers and the green chlorophyll normally associated with plant life. They obtain food for growth and survival by feeding on dead or living plants or animals.

Some fungi, which are called parasites, feed on living hosts. Others, which are called saprophytes, live on dead organic tissue. The parasitic fungi which cause disease are called pathogens. For example, the pathogen which causes brown patch is called *Rhizoctonia solani.*

Certain fungi feed only on living plants and though many parasitic fungi attack grasses, very few feed only on living tissue. They are called obligate parasites, and one of the most common are the *Puccinia*, or rust fungi.

Many parasitic fungi live dormantly as saprophytes until conditions become favorable for attacking living plants. Since they live primarily as saprophytes, they are called faculative parasites, and good examples of

this fungi are *Pythium* and *Rhizoctonia*. A contrast are those fungi that exist primarily as parasites, but can survive temporarily on dead tissue. *Helminthosporium* and *Ustilago* fungi are included in this group.

For an infectious disease to occur, there must be a host plant, an infectious fungi and favorable environmental conditions. A good food supply, proper temperature and adequate moisture are exceedingly important for continued infection. Infection starts when the mycelial thread, or the spore, makes contact with the grass plant. The spore produces a thread-like germ tube and it is most likely to enter the plant through a cut from the mower, or in some instances, actual penetration of the leaf surface. This penetration is most often through the stomates, but can occur through the epidermis. Some organisms, such as the *Pythium* fungi, can also enter the plant through roots, rhizomes and the crown itself.

The fungus feeds on plant tissue, as its transparent thread-like hyphae grow in length and develop many branches. Eventually, the fungus produces spores, sclerotia, or other unique reproductive parts. These unusual fungal structures may be carried by the wind, surface water, or mechanical means to new sites of infection. They also have the capability for tolerating a wide range of insufferable conditions until the environment again becomes favorable for infection.

Diseases of fall to early spring

Gray Snow Mold

Typhula Blight, Snow Scald
Typhula incarnata
Typhula ishikariensis

Sclerotia of *Typhula incarnata*

Sclerotia of *Typhula ishikariensis*

Host Grasses
All cool season grasses

Unlike pink snow mold, which can be destructive during any season, gray snow mold is strictly a cold weather disease. Plentiful moisture and near freezing temperatures can trigger activity, so in theory the disease can occur from fall to spring. But, the key environmental factor essential to gray snow mold is some kind of cover. Occasionally, this cover can be leaves or, in the case of new seedings, a protective mulch. But in a majority of occurrences it's a blanket or drift of slowly melting snow. Extensive injury is most likely to follow periods when snow has laid in place for several months.

In the western half of the United States, *Typhula ishikariensis* is the prevailing pathogen. In eastern states, *Typhula incarnata* causes destruction. There are naturally large areas of the country where both species occur simultaneously, but neither is a problem as far south as pink snow mold. There are no visible differences in disease damage between the two species, but there are exceptional differences between the sclerotia. Turf infected by *Typhula ishikariensis* has numerous, tiny black spores that appear like specs of black pepper on bleached grass blades. Sclerotia of *Typhula incarnata* are much larger, pinkish-brown to reddish-brown and not as plentiful.

Gray snow mold infections become more numerous with sufficient moisture and proper temperatures. They coalesce to damage large areas of turf. Permanent injury from crown and root rot is not infrequent, particularly on lush turf. Many times, the injury from light attacks of gray snow mold are quickly obliterated by high temperatures and normal spring growing conditions.

Symptoms

As snow starts to melt and air temperatures reach 30°F to 40°F, gray snow mold becomes infectious. Diseased turf first appears as yellow-green spots only a few inches across. If conditions remain favorable, these diseased spots grow in size and turn to a grayish-white. Leaves within the infection soon

A close-up of *Typhula incarnata* sclerotia

Gray snow mold mycelium on bentgrass

Overlapping patterns of gray snow mold in a lawn

Severe gray snow mold injury on a putting green

become matted and turn to a light tan. A narrow border of gray-white mycelium often continues to grow around the outer perimeter. These circular areas may spread to two feet in diameter, but a large majority will be less than a foot across. When the attack is severe, diseased spots become more numerous, run together and cause unsightly, extensive turf damage. If environmental conditions continue to favor disease growth, crowns and roots are destroyed and the turf suffers permanent injury.

In difficult situations the visual characteristics of pink and gray snow mold might be confused, but the two can be easily separated by the presence of sclerotia on gray snow mold. On *Typhula incarnata* these tiny, hardened, seed-like structures are about 3/16 inch in diameter and in some stage between a pinkish-brown or a dark red-brown color. Sclerotia of *Typhula ishikariensis* appear to be more plentiful but much smaller and brown to black. These tiny reproductive bodies can withstand great variations in temperature and other adverse conditions only to germinate when conditions become ideal.

Life Cycle

Typhula fungi spend the warm weather season as shriveled, almost invisible sclerotia. When temperatures cool in the fall and the environment becomes moist, many sclerotia germinate into small, white, "club-like" fruiting bodies called basidia. These basidia are little more than an eighth inch at the base and taper upward like a sharpened pencil for less than an inch. Atop the basidia a unique group of spores called basidiospores are formed. Basidiospores are carried by the wind to new sites of infection. Sclerotia that remained dormant in the fall germinate as snow melts to cause reinfestation of the turf and are probably more important to renewing infestation than basidiospores.

Pink Snow Mold

Host Grasses
All cool season grasses

Fusarium Patch
Fusarium nivale

A typical pink snow mold infection, with a "rusty-pink" border

Pink snow mold patches run together and increase turf injury

Snow molds are known for their ability to cause turf injury during very cool, wet periods. But even though melting snow often reveals large areas of pink snow mold damage, it can become infectious in nearly all seasons. If there is a time when this disease is predictably inactive, it's during the very hot weather of summer.

Pink snow mold, or fusarium patch, is a disease of cool season grasses and can occur in all temperate areas. It is considered to be the major disease in the Pacific Northwest, but it can occur south into California and all across the southern limits of the temperate region. In this particular area, it has greater potential for injury than any other snow mold.

Although pink snow mold can occur frequently without snow during spring and fall, it can become truly destructive when long periods of snow-cover protect the turf from "hardening off." As the snow melts upward from the turf, an ideal environment is created. Pink snow mold starts infection and can reach epidemic proportions before the grass ever becomes visible. On home lawns and golf courses, these are most likely to be the depressed, protected or shady areas where moisture is abundant and snow is slow to melt.

Other diseases may be regarded as more destructive, but during extended periods of activity, pink snow mold can readily develop into crown and root rot. In its most active form, it is often found intermingled with heavy infections of gray snow mold. Even though the two diseases seem to attack virtually together, they are different in life cycle and mode of action. Visual characteristics are somewhat similar, but generally quite distinct.

Symptoms

Pink snow mold can start infectious growth when there is abundant moisture and temperatures reach 32°F to 45°F. The infection, which often accompanies melting snow, starts by forming yellow-green, circular spots in the turf. These spots are soon covered with white mycelium and vary in size

Melting snow first revealed this pink snowmold on a bentgrass putting green

from a few inches to more than a foot in diameter. In wet turf, the diseased grass blades gradually mat together and feel slippery or slimy to the touch. The white mycelium soon turns to a light pink. Dead leaves within the infected area turn to a light, bleached tan and as long as disease activity continues, the outer edges remain a darker rusty-pink. An intrusion of pink snow mold is generally most obvious and typical on closely mowed bentgrasses. Heavily diseased turf will exhibit a running together and coalescing of infected patches, and quite often extreme injury.

Without snow cover, pink snow mold occurs mostly as rusty-brown patches. These patches, while not as striking as those developing with snow, vary from mere spots to six or eight inches in diameter. Disease infestation with pink snow mold can continue as long as there is plentiful moisture and temperatures do not exceed 65? Even though there are periods of dormancy during extreme temperatures, some degree of pink snow mold activity is always possible from fall through spring. During cool, dry days in fall, it can be a special problem on new seedings, when constant sprinkling is necessary.

Life Cycle

Fusarium nivale is capable of surviving non-infectious periods as dormant mycelium in infected plants, or in previously diseased debris. When temperatures reach the 32°F to 45°F range, and sufficient moisture is present, pink snow mold becomes active. Spores are carried by the wind or free surface moisture to adjoining healthy plants. Grass blades become infected and disease activity continues until conditions for *Fusarium nivale* are no longer favorable. This is usually the result of sunshine, rising temperatures and drying winds.

Cool Weather Brown Patch

Yellow Patch
Rhizoctonia sp.
Ceratobasidium group
Host Grasses
All cool season grasses

Infected turf shows some thinning, but seldom serious injury

Disease patterns often occur with various forms of snow mold

Cool weather brown patch is a disease which has been reported in varying degrees across most temperate regions. It seems to affect most cool season grasses, but it has become particularly noticable and objectionable on bentgrass putting greens. Cool weather brown patch has been mentioned in casual literature and discussed by professional turf managers for many years, but only in recent times has it been subjected to analytical study.

Symptoms

Cool weather brown patch is often found simultaneously with various forms of snow mold injury, but it also occurs during cool, wet weather over a wide range of temperatures. Most infestations have been observed in fall and early spring. The infection appears in circular patterns that range in size from a few inches to nearly two feet in diameter. Blades are bleached and the outer edge can be covered with a grayish-brown mycelium, while light tan sclerotia may be found near the crowns of the plants. Grass within the diseased area retains its color. Many rings, or patches, often occur in a small turf area and often run together to form a mottled pattern.

Cool weather brown patch can cause some thinning of turf, but it seldom reaches stages of extensive injury. In most instances, an increase in air temperature will be accompanied by a gradual disappearance of the disease. By the time the turf has been mowed several times, all traces of the infection have faded away.

Life Cycle

Until recently, *Rhizoctonia solani*, the same pathogen that causes true brown patch, was considered to be the culprit in this cool weather infection. Increased investigation places some doubt on this theory and evidence suggests the actual pathogen may be a species of closely related *Ceratobasidium*. Only continued scientific evaluation will determine ranges, limitations and causes of this disease.

Diseases of spring and early summer

Leaf Spot

Melting Out, Crown Rot, Foot Rot,
Helminthosporium sorokinianum
Helminthosporium vagans

Primary Host
Kentucky bluegrass

Leaf spot in the crown rot stage

Helminthosporium turf diseases are widespread and under proper conditions attack nearly all grasses. They are especially destructive in susceptible varieties of Kentucky bluegrass. Most turf diseases are dramatic and conspicuous in their damaging activity, but *Helminthosporium* diseases can reach epidemic proportions in a very quiet and subtle manner. Turf is thinned severely and the resultant injury is often blamed on drought, or a host of other causes.

Although the characteristics and pattern of injury for each *Helminthosporium* disease is unique, in many ways they are all very much alike. Consequently, common names that have evolved through the years only add confusion to identification and description. Terms like leaf spot, leaf blight, leaf blotch, melting-out, crown rot and foot rot can be used to describe conditions and also the common name of specific pathogens, but they are also used interchangably between each disease. So, it is not unusual to hear about the leaf spot stage of "melting-out" disease, nor the melting-out stage of "*Helminthosporium* leaf spot." Regardless of the specific pathogen, a professional turf manager almost always refers to the infestation as "leaf spot." The two major pathogens are *Helminthosporium vagans*, "melting-out" and *Helminthosporium sorokinianum*, "*Helminthosporium* leaf spot." In general appearance these two diseases are basically the same and actual identification of each disease requires microscopic analysis. "Melting-out" causes damaging infestation in cool, moist weather of spring or fall, while *Helminthosporium* leaf spot is a warm weather disease. It is not unusual, however, to find combinations of the two

Leaf spot lesions on bluegrass

Severe leaf spot injury in bluegrass

diseases in any leaf spot infection.

Symptoms

Leaf lesions for *H. vagans* and *H. sorokinianum* are first observed as small, oblong, purplish-brown spots on the upper surface of the grass blade. These lesions are often tan colored in the center. As the disease progresses, lesions run together and eventually cause the leaf to shrivel into a lifeless, dull brown. Infection is not confined to the blades. Lesions often appear in irregular patterns on the sheath. As the disease increases and progresses, the whole lower part of the plant may appear to be rotting away. This condition is known variously as "foot rot," "crown rot," and even "root rot." All life processes are destroyed. The plant withers into a lifeless form that completes the "melting-out" process. At this time, turf is destroyed and thinned to such a degree that a perfect situation is created for the invasion of weeds and unwanted vegetation. During this melting-out process, it is not unusual to see the homeowner fertilize and water the infected area. Both procedures could only compound the problem.

If weather remains moist and overcast with moderate temperatures, *Helminthosporium* increases in intensity and infection will grow in severity. All conditions must be in balance and even the appearance of sunlight alone has a great effect on inhibiting continued infection.

During hot weather, *Helminthosporium* infection is generally restricted to areas of greatest damage, the crowns and the roots. Many times there is very little indication of leaf spotting and turf may be destroyed in large, irregularly shaped areas. This condition

A bluegrass lawn severely thinned by leaf spot

resembles drought damage and in some instances an iron chlorosis. In the fall, when temperatures moderate, infection again becomes more visible on the leaves. The severity of infection and whether or not fungicides have been used play a significant role in determining the probability of recurrence during the following spring and summer.

Disease Cycle

Helminthosporium fungi all have essentially the same life cycle. The disease overwinters in crowns, roots and rhizomes of diseased plants or in the debris of turf destroyed by the disease. When temperatures warm in the spring (55° F to 70° F), *Helminthosporium vagans* is carried onto the healthy plant leaves by splashing water and air movement. The disease enters the leaf through stomates and between cells. It continues reproductive and tissue destroying processes as long as environmental conditions remain in favorable balance. As temperatures warm, the melting-out stage becomes more severe. *Helminthosporium sorokinianum* starts infection near 70° F and becomes most destructive above 90° F. Both of these major *Helminthosporium* diseases have also been associated with root infections of seedlings.

Other *Helminthosporium* Diseases

Helminthosporium blight, netblotch, *(H. dictyoides)*. This is an important disease of tall fescue, meadow fescue and fine fescue. Its pattern of infestation and destruction is very similar to *H. vagans*. Infection and leaf spotting start in spring, followed by extreme damage in hot, dry weather of summer. The name "netblotch" is derived from

Brown blight lesions on perennial ryegrass

Red leaf spot injury on a bentgrass putting green

the initial disease injury on the blades of tall and meadow fescue. Short, fine, brown threads of diseased tissue join together to form a net-like appearance. Eventually, these net-like formations fuse together into large dark spots.

Heminthosporium leaf blotch, *(H. cynodontis).* Bermudagrass is the host for this particular species of *Helminthosporium.* Infected turf takes on a bleached, or straw colored appearance measuring from a few inches to several feet in diameter. Lesions form as small olive green spots, enlarge into irregularly shaped blotches, and then turn brownish-black. Leaf blotch becomes a problem in cool, moist weather and often moves into crown and root phases during hot weather.

Red Leaf Spot, *(H. erythrospilum),* is a spring disease of bentgrass. Initial infection starts with circular reddish-brown lesions, with straw colored centers. As the disease progresses, leaves wither and die giving the affected turf an overall appearance of drought damage. Severe thinning of turf can result if the disease continues.

Brown blight, *(H. siccans)* Annual and perennial ryegrasses are infected by brown blight. Many tiny brown lesions appear on the blades and these are often accompanied by dark brown streaks. Blades turn yellow from the tip back and then die. As with other *Helminthosporium* diseases, severe thinning often follows.

Red Thread

Corticium fuciforme

Primary Hosts
Creeping red fescue
Ryegrasses

Typical red mycelial threads associated with this disease

Since red thread is a disease of cool, wet weather, it occurs primarily in the spring and fall, but coastal regions with long periods of light rain and fog are more frequently susceptible. Nearly all temperate climate grasses can be infected, but red thread is especially distinctive and harmful on creeping red fescue and ryegrasses. In the South, bermudagrass is occasionally attacked.

Red thread is associated with periods of slow growth. Many times infected turf has been improperly fertilized and a lack of warm growing weather helps compound the problem. On golf courses, it's the unfertilized roughs which are generally attacked first, while low maintenance home lawns are equally vulnerable.

Although red thread does not progress into the crown and root rot stages, infected sheaths and blades can lead to severe turf injury. Diseased areas are roughly circular in pattern, but usually lack a sharp definitive outline. A number of healthy blades rise from the decaying tissue. In a casual observation, the disease is often confused with dollar spot and then as it spreads and progresses, melting out. Only close inspection can reveal the fine, pinkish-red fungus strands associated with the infection.

Symptoms

Red thread can become active over a wide range of temperatures, but peak activity generally occurs between 60°F to 75°F. Turf appears blighted and discolored in patterns from two inches to several feet in diameter. Patterns are circular but not sharply defined, and many live shoots still grow in the infection.

When moisture is plentiful, the

Pinkish mycelium often found with red thread

A close-up view of red thread

Red thread injury in perennial ryegrass

pathogen forms tiny pink to red gelatinous masses on leaves and sheaths of grass plants. These masses, called stroma, are joined together by a pinkish web of mycelium. Both the stroma and the mycelium are capable of starting new outbreaks of red thread infection.

As the disease progresses, affected leaves and sheaths look water soaked and lifeless. This tissue eventually collapses and fades to a light tan color. In addition to the gelatinous masses, many of the blades are terminated by fine reddish mycelial threads. These threads, which may be solitary or slightly branched, are most evident when infection has reached its peak. When the disease is finally arrested, reddish fungal growths shrink, dry and become brittle.

During active stages, red thread can be carried to new sites of infection by mowers and other turf equipment. The infectious fungal structures can also be transported by the wind.

Life Cycle

Corticium fuciforme, the red thread pathogen, overwinters as stroma and as dormant mycelium. These fungus structures survive in diseased tissue and in the debris of previous infections. Disease activity is favored by extended periods of cool, moist weather, below 75°F, when turf is growing very slowly. It spreads by stroma and mycelial growth, which move from plant to plant. Breezes, foot traffic and equipment also carry these infectious parts to new sites of activity. Red thread generally ceases as temperatures rise, or when conditions become more favorable for good turf growth.

Spring Dead Spot

Primary Host
Bermudagrass

Bermudagrass will be extremely slow to recover in this spring dead spot infection

Spring dead spot can cause more severe injury to bermudagrass than any other disease. It occurs across cooler areas of the bermudagrass region and is most severe where there are extended periods of dormancy. Spring dead spot has long remained an enigma, because its true cause has never been isolated. There is no specific pathogen and consequently this disease has been associated with an endless number of causes. They range from soil fertility, to maintenance, to nematodes and a number of familiar turf disease fungi. Each one could have a relationship, for it is generally believed that this disease may be the result of several factors.

Spring dead spot is a disease of well maintained turf and particularly hybrid bermudas. It infests home lawns, athletic fields, and can produce havoc on golf courses. Infected bermudagrass has very little inclination to repair itself and healthy, spreading stolons do not want to root into diseased sod. This results in unslightly, rough textured, weedy turf and getting that turf back into good condition is generally a lengthy process.

Symptoms

Spring dead spot never becomes truly evident until the bermudagrass is well out of winter dormancy. Circular areas that range in size from a few inches to three or four feet in diameter remain straw colored, without a sign of life, long after surrounding turf has turned a lush green. All stems, roots and stolons within the infected area appear black and rotted. Runners from healthy turf have difficulty moving into the diseased areas and the dead spots only turn green with the appearance of weeds, or weedy grasses.

Two views of spring dead spot on bermudagrass fairways

Spring dead spot is an intolerable problem on putting greens

Infected spots do not increase in size during the growing season and the following spring they reappear in the same location. Many times they are much larger than the previous infection and run together, or coalesce, into larger forms of damage.

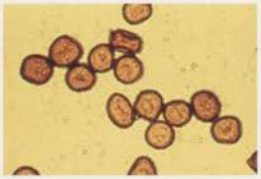
Spring dead spot occurs on well maintained turf that has developed a strong layer of thatch. It seldom occurs where thatch is minimal, or where there is good thatch removal maintenance. Because thatch is a contributing factor, spring dead spot is seldom found in newly established turf.

Life Cycle

Since the cause of this disease has never been determined, it is surrounded by hypothesis and theory. There have been many attempts to associate spring dead spot with everything from insects, to fungi, to a type of soil borne root rot. But, all attempts to create the specific set of factors associated with this disease have never been successful. The diseased turf does appear to give off a toxic substance that inhibits growth, but even this is only conjecture. Until the cause of spring dead spot is finally determined, only good cultural practices can aid its prevention.

Stripe Smut

Ustilago striiformis



Primary Host
Kentucky bluegrass,
Creeping bentgrass

Black spore masses rupture the veins of these Kentucky bluegrass blades

When temperatures remain between 50°F and 60°F for extended periods, stripe smut symptoms become most evident. Infected plants generally form a circular pattern only a few inches in diameter. Growth is stunted, weak and upright. Blades turn a yellow-green and veins become streaked with gray. The gray streaks soon become black as the veins rupture and release masses of spores. Spores are easily transported by winds to new sites of infection.

Eventually, the diseased blades shrivel, die and turn to a light brown color. Turf becomes thin in spots and very uneven. The symptoms of stripe smut often linger with little apparent injury, but quickly turn to severe damage with hot, dry weather.

Stripe smut consists of many different races and certain varieties of Kentucky bluegrass offer varying degrees of susceptibility and resistance. For this reason, planting blends of grasses appears to be a good approach in preventing severe infestations.

It is possible for stripe smut to go through several growing seasons without becoming really obvious and destructive. Unless conditions are favorable for its growth, there will be no outbreak. Once the turf has been infected, there is always a strong, lingering potential for re-infestation.

Once a grass plant is infected with stripe smut, it remains infected forever and offspring produced by rhizomes, or tillers must share the same fate. The pathogen lives within the plant's vascular system, even though outward visible symptoms are not always present. It becomes active and injurious only during those times when temperature and moisture become favorable.

Unlike most turf diseases, stripe

As stripe smut progresses, blades turn yellow-green then shrivel and curl to a light brown

smut does not attack foliage. It gains entrance into the plant only through the lateral buds of rhizomes and soon infects tillers or new plants arising from additional rhizomes.

Symptoms

The symptoms of stripe smut become evident during extended periods of warm, dry weather in late spring and fall. Severe injury generally occurs during hot days of summer and particularly during periods of drought. Ample watering can do much to prevent the actual death of plants. Turf weakened by stripe smut is especially susceptible to attack by other organisms. For example, leaf spot in combination with stripe smut can be particularly devastating.

Stripe smut can be carried on the surface of the grass seed and can enter the new grass plant as it germinates. The newly seeded turf shows no injury and is generally three or four years old before symptoms appear. This is a stage where rhizoming is heavy and infection through this part of the plant is most probable. Fortunately, many improved varieties of grasses are resistant to the disease.

Life Cycle

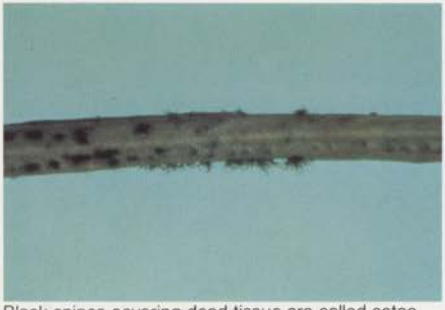
Stripe smut survives dormant periods in the crown and vegetative parts of infected plants. Spores act as a constant threat of infection by surviving in the soil and in thatch. When conditions favor the disease, mycelium starts growth and eventually the black spore masses are scattered to start new infections. Spores either penetrate the coleoptile of new seedlings, or enter older plants through tillers or rhizomes.

Diseases of summer and early fall

Anthracnose

Colletotrichum graminicola

Primary Host
Poa annua



Black spines covering dead tissue are called setae

In turf management, *Poa annua* has always been categorized as a weak annual grass that dies in the heat of summer and reappears during cool, wet weather. The merits of *Poa annua* are still questionable, but much of its weakness is now attributed to anthracnose. Although anthracnose does infect other grasses, it is particularly damaging to the close-cut *Poa annua* on all northern golf courses.

Anthracnose is not a sudden, dramatic disease and is generally considered of minor importance. During much of the growing season, it can cause a lingering discoloration without doing apparent injury. When the air becomes saturated with moisture and temperatures reach 80°F, anthracnose becomes destructive. If conditions persist, damage often becomes extensive. Injury is most severe where soil is compacted, drainage is poor, traffic is heavy and fertility levels low.

The discoloration of turf associated with anthracnose is often mistakenly diagnosed as wilt. This is especially true when the grass is *Poa annua,* a grass that has a reputation for "drying out" in hot weather. When grass wilts, good turf management dictates the necessity for a heavy application of water. This increased moisture creates an even more desirable environment for the spread of anthracnose.

Symptoms

Turf that is suffering from stress is highly susceptible to anthracnose. Stress could be the result of a low fertility, lack of moisture, heavy mechanical or foot traffic, or any condition where normal growth is impeded. Infection and discoloration can occur in cool weather, but serious damage follows high temperature and humidity.

Anthracnose destroys *Poa annua*, leaves bentgrass

This injury caused by prolonged hot, humid weather

A golf course fairway ravaged by anthracnose

Discoloration is first observed in patches that range from a few inches to a dozen feet in diameter. As conditions become more favorable for the disease, turf turns to yellow and then to bronze. Elongated reddish-brown lesions can be found on the grass blades, and they often enlarge to cover the entire blade. As the infected turf dies, it fades to a light tan.

A key feature of anthracnose is found when the disease reaches advanced stages. Small, black, mold-like fruiting bodies called acervuli grow outward through the surface of the blades. They can be numerous and often spot the leaves of infected plants. Acervuli are particularly evident on dead leaf tissue destroyed by the disease. These black spots are covered with tiny spines called setae, which distinguish this pathogen from similar harmless fungi. The setae are very easily observed with a hand held magnifying glass.

Turf infected with anthracnose does not suffer complete destruction. Enough life remains in roots and crowns to allow regrowth.

Life Cycle

The pathogen that causes anthracnose, *Colletotrichum graminicola,* is capable of surviving from season to season in plant residue. It can also survive in the sheaths of grass plants. When temperature and moisture reach a favorable balance, a new reinfection is started. Anthracnose is easily transported from place to place in grass clippings.

Brown Patch

Rhizoctonia solani

Host Grasses
All turfgrasses

The typical "smoke ring" of brown patch

In temperate areas of the country, brown patch is most likely to become active during the late spring and summer. Infestation is swiftly triggered when nights are warm, winds are calm and the air is saturated with moisture. Closely mowed turf and particularly the bentgrasses of golf courses are especially susceptible and easily damaged. Under ideal conditions many parts of tees, greens and fairways can be attacked simultaneously. Bluegrasses are also infected by typical brown patch. Characteristics are often masked, or totally lacking. In the cool coastal regions of the Pacific Northwest, brown patch is rated as only a minor problem. All southern grasses are affected in varying degrees, but it can become extremely destructive on St. Augustinegrass from fall to early spring. Injury often covers large areas of turf and it is not unusual to see much of an entire lawn infected. During this same period, brown patch can be a particular problem on golf greens and other turf areas which have been overseeded to ryegrass.

Moisture on the grass blade is essential to the spread of brown patch. If the air is saturated and atmospheric conditions favor moisture retention, an ideal situation is created. Guttated droplets clinging to the tips of blades not only contribute to this infectious environment, but also serve as a valuable nutrient source for the disease.

The most vivid characteristic of brown patch is the "smoke ring" commonly associated with the disease. When disease activity is the greatest, this ring of dark gray fungus mycelium often surrounds the infected area, but disappears as the foliage dries. Even though this is considered as a key identifying feature, unfortunately it is not always present.

Symptoms

Perfect conditions develop for the *Rhizoctonia* pathogen when temperatures remain consistantly above 70°F and atmospheric moisture is correspondingly high. Initial infection starts in a circular pattern, which may be no more than a few inches

Brown patch on a golf course putting green

Kentucky bluegrass infested with brown patch

Brown patch in closely mowed perennial ryegrass

across. As the disease increases in intensity, the affected areas may grow up to several feet in diameter. Blades turn from a water soaked purplish-green color to dark brown and eventually wither and dry to a pale light brown. A "smoke ring" of dark gray mycelium may surround the infection and on overcast, moist mornings it can persist well into the day. With sun and drying breezes, activity ceases and the smoke ring disappears. In many instances, brown patch can be active for some time without any impressive visible symptoms and light attacks often cause only wilting. If temperatures remain in the 80°F to 85°F range, with high humidity, damage can be severe. As temperatures rise above 90°F, activity ceases.

Infestation on St Augustinegrass is roughly circular, lacks the smoke ring, and can cover large areas of turf. Since brown patch is a winter disease in the south, it is most destructive between 60° and 75°F and ceases activity above 75°F. Although crown and root rot are common in severe brown patch attack on all grasses, St. Augustinegrass often shows the most destruction.

Life Cycle

Rhizoctonia solani, the brown patch pathogen, spends dormant periods as sclerotia. These small round bodies, about a sixteenth of an inch in diameter, are dark brown to black and compare very roughly to the seeds of a flowering plant. They are formed on the lower parts of infected plants or in soil debris. When temperatures reach the germinating period, mycelial threads spread outward from the sclerotia to start infection. Sclerotia of *Rhizoctonia* can survive for a number of years in the soil under many adverse conditions.

Dollar Spot

Sclerotinia homoeocarpa

Primary Host
Creeping bentgrass

Dollar spot mycelium on bentgrass

Dollar spot attacks nearly all turfgrass in varying degrees, but is most common on the bentgrasses of northern golf courses. It is not a disease that strikes with the swiftness of pythium, or brown patch, nor is it as destructive as leaf spot. But dollar spot that is allowed to spread uncontrolled over large areas of turf can do extensive harm. It might be considered a disease of impoverished or neglected turf, for it often attacks areas that are under a moisture or nutritional stress. The nutritional stress is primarily a lack of nitrogen. An adequate or balanced supply of nutrients may give turf the vigor to withstand infection, but its presence is most often considered a prime benefit in aiding recovery. Once dollar spot has gained a foothold, it can spread easily. Bits of diseased grass plants are carried from place to place by mowers, sweepers and other maintenance equipment. On golf courses, the golfer himself contributes to the problem by tracking the disease from tee, to fairway, to green and even to other courses.

Dollar spot is practically nonexistant in the Pacific Northwest and also in some parts of hot, dry, western states. In northern areas, it is most obvious on bentgrass, but can cause damage to Kentucky bluegrasses, the fine fescues and very rarely the ryegrasses. In high cut grasses such as Kentucky bluegrass, infections are mostly six to ten inches across and generally lack the specific, sharp definition that occurs in bentgrass.

Symptoms

Dollar spot has an extensive activity cycle that ranges from 60°F to 90°F, but greatest activity occurs between 70°F and 80°F. Although the disease is known to thrive during dry seasons, there must always be sufficient moisture at the site of infection for the disease to grow and spread. First stages of dollar spot are observed as water soaked spots that vary in size from a fraction of an inch to approximately three inches in diameter. Dark, wilted blades within the infected area eventually take on

The "hourglass" lesion associated with dollar spot

A close-up of typical dollar spot infestation

General view of dollar spot disease

a bleached, straw-colored appearance. During early morning hours, when moisture is on the turf and the disease is active, tufts of white, cotton-like mycelium spread in tiny, delicate webs across the infected spots. As the sun rises and air movement increases, mycelial growth ceases and slowly disappears.

When the diseased spots have progressed to a bleached, strawlike stage, typical dollar spot lesions may be found. These lesions are shaped like an "hour glass" and are formed by the diseased tissue that spreads across what appears to be an otherwise healthy blade. The "hour glass" lesion is light tan and often has a reddish-brown border. Other blades may be diseased and light tan from the tip downward for about an inch. Dollar spot damage is primarily an action of blade and sheath infection to destroy life giving processes.

If the dollar spot infected turf is left uncontrolled, the number of diseased spots increase. Eventually, they run together or "coalesce", and large areas of turf can become mottled with irregular patterns of extensive damage. Dead tissue within the infected areas mats together and forms depressions. Recovery from severe dollar spot can be extremely slow and, in many instances, only complete renovation can bring the turf back to normal.

Life Cycle

The dollar spot fungus, *Sclerotinia homoeocarpa*, overwinters in the form of sclerotia and as dormant mycelium in crowns and roots of infected plants. The sclerotia appear as tiny, thin, black flakes. When temperatures warm to 60°F, dollar spot is capable of becoming infectious.

Fairy Ring

Agaricus campestris,
Marasmius oreades,
Lepiota morgani,
and many other fungi

Host Grasses
All grasses

Some fairy rings start with the appearance of mushrooms

Many fairy rings disappear just as suddenly as they appeared

Fairy rings occur wherever grass grows and throughout history their appearance has been surrounded by mystery and mythology. In some countries they are considered to be the artwork of gremlins or monsters and, depending upon the point of view, either objects of misfortune or great luck. Even though science has eliminated much of the myth, fairy rings still lack complete understanding.

Fairy rings occur in soil that is high in organic content and particularly in turf that covers places where forrests once grew. Fungi that aid the decay of buried logs, stumps and other bits of wood also contribute to the formation of fairy rings. Many species of fungi can be involved and they perform in many different ways. Some fairy rings cause only a slight greening and last for only a brief time. Some are more obvious, last longer, do very little damage and eventually disappear. The most unsightly and troublesome are those that reappear and spread each year, while leaving large ugly scars. This is a major turf problem that can only be eliminated through major, complete rebuilding.

Symptoms

The dark green arcs or circles formed by the fairy ring fungi are caused by a rapid release of nitrogen. Dense, white mycelium, not visible on the surface, moves outward through the soil and follows the spreading green ring. This mycelium is impervious to water and prevents water from penetrating into the diseased area. Excessive nitrogen and hydrogen cyanide produced by the fungus are also considered factors that help destroy the turf. When tapped with the fingers, this matted dead area sounds hollow

Fairy rings on this bermudagrass putting green present an unusual golf course maintenance problem

and empty.

Fairy rings are viewed as circles or part circles of darker and faster growing grass than the grass that surrounds it. Quite often these dark green rings contain "mushrooms" or "toadstools," which are the fruiting bodies of the particular fungi causing the fairy ring. Fairy rings spread outward from a central point and may vary from three or four feet to nearly two hundred feet in diameter. The width of the ring may be only a few inches or almost two feet. It is not unusual to see a fairy ring spread out across a golf course fairway and persist for many years. Others are much smaller, inconspicuous and appear and disappear without any apparent damage.

In destructive fairy rings, primary turf stimulation occurs outside or ahead of the dying turf. It follows the path of spreading below ground mycelium, which moves outward slowly. Activity of the fairy ring will naturally cease if it meets a barrier such as a wall or sidewalk, but running into an entirely different soil type can have the same effect. Fairy rings do not move across or overlap each other and activity ceases where they meet. The rate of outward spread is not predictable and depends upon growing conditions favorable to the fungus involved.

Life Cycle

Fungi that cause fairy ring survive as spores, or as inactive mycelium. They are associated with organic matter and especially pieces of buried wood. The infection starts with a cluster of mushroom-like structures that gradually assume a circular form. Conditions that trigger fairy ring infections and the regrowth that recurs from year to year are not precisely known.

Fusarium Blight

Fusarium roseum,
Fusarium tricinctum

Primary Hosts
Bentgrass,
Kentucky bluegrass,
Creeping red fescue

Lesions associated with Fusarium blight infection

Fusarium blight can be a particular problem across the Midwest to the mid-Atlantic states and in the state of California. It is most injurious to bentgrass, Kentucky bluegrass and creeping red fescue, but in the southern limits it can also affect centipedegrass and bermudagrass.

Fusarium blight is a disease of high light intensity and is most likely to occur on sloped areas, which receive long daily exposure to sunlight. It can also be severe in places with reflected heat, or where turf is growing on heavily compacted soil. In contrast, disease symptoms do not occur in heavily shaded areas. Turf with heavy thatch is generally most susceptible to damage from Fusarium blight, while newly seeded turf is rarely infected.

Although Fusarium blight becomes infectuous during periods of high temperature and humidity, it is most damaging during periods of moisture stress. Hot, dry weather following extended periods of rainfall are particularly favorable for extreme infections.

When conditions are proper for Fusarium blight, it is not unusual to see many home lawns and larger turf areas with excessive injury. Once established, the disease can occur in almost the exact same place year after year.

Symptoms

Turf infected with Fusarium blight is first observed as pale green patches ranging in size from a few inches to several feet in diameter. Patches may be circular, part circles or irregular streaks. The infection soon fades to a wilted purplish green and eventually to a lifeless, dull straw color.

In circular infections, the grass often stays green and growing in the center,

The pattern, or "frog eye" associated with Fusarium blight

Injury from this disease may form in the same place during coming years

while surrounded by a ring of dead turf. This pattern, which is considered to be typical of Fusarium blight, is called "frog-eye." Although the "frog-eye" is almost always present to some degree, in certain varieties of grasses the entire circular blight is destroyed.

Individual grass blades within the infection have irregularly shaped dark green blotches, which eventually turn light green and then tan. These lesions may extend across the width of the entire blade.

When temperatures remain consistently near 90°F during the day and 70°F at night, with correspondingly high moisture, the disease spreads. Blighted areas soon run together and large sections of turf can be destroyed. A pinkish colored mycelium is often visible near the base of the plants. Roots within the diseased areas are poorly developed and stunted. They remain this way long after the turf appears to be recovering. For this reason, disease severity and recovery are often helped by frequent light watering.

Life Cycle

Both species of *Fusarium* survive non-infectious seasons as dormant mycelium in previously infected plants and thatch. Infection occurs through the cut tips of grass blades and between the cells on the leafs surface. High humidity is essential for initial infection and the temperatures should stay constantly above 75°F. When conditions are favorable, infection can occur in a matter of hours.

Ophiobulus Patch

Ophiobulus graminis

Primary Host
Creeping bentgrass

The typical pattern of Ophiobulus patch

Many turf disease fungi were originally observed as parasitic problems on agricultural crops and such is the case with *Ophiobulus graminis.* It received very early recognition as a disease causing pathogen in cereal grains but much more recently in turf. Although it has the capability for attacking many cool season grasses, the degree of injury is extremely variable. Creeping bentgrasses are especially susceptible to severe damage, while perennial ryegrass and Kentucky bluegrass are much more resistant. Even though Ophiobulus patch is now a well established turfgrass disease, its area of adaptation is limited primarily to coastal regions of the Pacific Northwest and the mid-Atlantic states northward through New England.

Ophiobulus is a disease of warm, moist weather and occurs most frequently during spring and fall. It is particularly damaging on poorly drained soils. Turf that has been infected by Ophiobulus patch is very slow to show new growth and recovery. Many times the blighted appearance lingers for several months and quick repair can only be accomplished through reseeding or resodding.

Ophiobulus patch has a unique sensitivity to soil acidity and it can be particularly severe where there is an alkaline imbalance. Controlling the level of acidity can be especially significant in the prevention of this disease.

Symptoms

When conditions are favorable, Ophiobulus appears as circular patches of bleached, straw-colored turf. These diseased patches can grow rapidly and vary in size from a few inches to several feet in diameter. As the infection

Advanced stages of injury in bentgrass

Ophiobulus causing damage to this bentgrass fairway

progresses, patches overlap to form large irregular patterns of destruction and color can vary from light brown to grayish-tan. Turf is dead and there is seldom any regrowth within the infection for a period of several months.

Ophiobulus spreads over the turf, but is essentially a disease of crowns and roots. They pass through a dry rot phase, disappear and the dead turf can be easily pulled or peeled away from the soil. Black mycelial growth can be seen protruding from lower parts of the sheaths. Eventually, an invasion of weeds and annual bluegrass generally starts growing in the infection. They spread outward from the center and give the turf a "halo", or "doughnut" appearance.

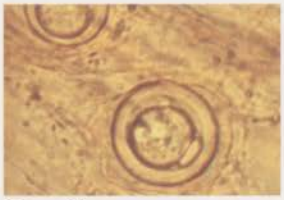
Ophiobulus can be especially damaging on new seedings, particularly where soil sterilants have been used. After two or three years, the susceptibility decreases.

Life Cycle

Ophiobulus graminis survives inactive periods in the debris of previously diseased turf and as dormant mycelium in the basal tissue of living plants. When atmospheric moisture persists, mycelium penetrates roots, crowns and the tissue of lower plant parts. The infection spreads outward from plant to plant and moves to new sites when infected tissue adheres to mowers or other maintenance equipment.

Pythium Blight

Cottony Blight, Grease Spot
Pythium aphanidermatum,
Phthium ultimum



Host Grasses
All cool season grasses,
Bermudagrass

The cottony mycelium associated with pythium

Pythium blight is a swift, devastating disease that has the capacity for destroying large areas of fine turf within a matter of hours. It is the one disease which commands immediate attention and great respect from a majority of turf professionals. For at some time, most have witnessed the results of its unbelievable destruction.

Although pythium blight can be a problem in most areas of the country, it is primarily a disease of cool season grasses. It occurs across northern regions during hot summer weather, when winds are calm and the air is saturated with moisture. Water logged, poorly drained turf is particularly susceptible to infection.

In warmer climates, pythium blight often attacks bermudagrass, but injury is generally light and seldom extensive. It can also cause severe damage on southern overseedings and poses a constant threat throughout the growing season.

During favorable conditions, pythium blight can be anticipated, but it is almost impossible to visualize a picture of its destruction. There's never a nice clean infection, which neatly destroys a large, solid mass of turf. Instead, its destruction is a "hit and miss" series of spot-like blights, which drift, streak and run together. The results can only be described as stark and ugly.

Symptoms

While pythium blight becomes infectious between 85°F and 95°F, it can occur on southern overseedings at temperatures as low as 68°F. Calm breezes, excessive moisture and lush turf are also key factors that contribute to infection. The disease spreads rapidly and can destroy large areas of turf overnight.

Pythium first appears as roughly circular spots that vary from a fraction of an inch to nearly six inches in diameter. Grass plants within the spots look dark, slimy, greasy and often mat together. They may be covered with a mass of white cotton-like mycelium. Mycelium can remain active

This phythium damage occurred in oppressive hot, humid weather

Streaks of pythium on the edge of a golf green

and visible far into the day, as long as there is plentiful moisture on the plants and very little bright, drying sunlight. Frequently, the infection looks streaked as it follows channels of natural surface drainage and paths of mowing equipment. In severe outbreaks the disease patterns keep growing and eventually run together to destroy large sections of turf. As the infection dries, it turns reddish brown and eventually fades to a light brown.

A sudden change in humidity, a drop in temperature or a strong drying wind can cause pythium blight activity to cease. But the disease often reappears on successive days, if only for a few hours, when conditions again come into balance.

On high-cut Kentucky bluegrass, disease patches are generally somewhat larger. Blades surrounding the infection often reveal "hour glass" lesions similar to those found in dollar spot. But, unlike dollar spot, the pythium lesion lacks a reddish-brown border.

Life Cycle

Both species of *Phythium* survive in the soil and as dormant mycelium in previously infected turf. When conditions are favorable, the disease invades roots as well as plant tissue and spreads from plant to plant by active mycelium. *Pythium* thrives in wet debris and is often spread by irrigation water from ponds. It can be spread over great distances through the movement of soil and infected plant parts. Calcium deficient and highly fertilized soils cause turf to become more susceptible to infection.

Slime Mold

Physarium cinereum,
Mucilago spongiosa

Host Grasses
All turfgrasses

General view of slime mold

Most turfgrass diseases are caused by infectious, parasitic fungi that destroy turf. Technically, the slime molds do not fit in this category because they do not actually cause disease. They merely use grass plants as a place to live during one stage of their life cycle. But while they are attached to the grass plants, they can shade and suffocate leaves to such an extent that normal plant processes are severely disrupted. If the disease persists, blades can become discolored and weakened, but permanent damage is extremely unusual.

Slime mold is not a disease of nutritional abuse, nor is it associated with any kind of turf stress. It often appears on low cut, well-maintained turf and most frequently following prolonged periods of heavy moisture. This makes spring an ideal season for slime mold, but it can be a problem in summer or fall as well.

Slime mold gets its name from a seldom-seen stage in its life cycle. An unsightly, slimy, water-like substance works its way out of the soil or plant debris and spreads itself over a small section of grass. As this slimy material dries, it turns to tiny powdery masses that cover blades and stems. It's in this latter stage that the disease is almost always first observed.

Symptoms

Following wet, warm weather, a slimy translucent growth spreads over low growing grass and the soil surface. The color of the substance may vary from creamy white to gray. It assumes irregular shapes that vary in size from less than an inch to more than a foot across, and on some occasions even forms streaks. Unlike other turf diseases which generally attack only


A blade of tall fescue with sack-like spore enclosures


The color of slime mold infestations can be variable

specific grasses, slime mold covers weeds or any other vegetation that happens to be in its path.

The slimy substance dries to form a dull, blue-gray, ash-like material that covers grass blades and stems. Close examination reveals that the ash-like particles are shaped like rounded, sack-like structures. These tiny sacks crumble like dust when pressed between the fingers, and winds can carry the dust-like purple spores to new infection sites. Brushing or washing these spore masses off grass blades can prevent the possibility of injury, but in wet weather it can spread the infestation to healthy turf.

It is not unusual to find slime mold spore masses that are black, yellow or various other colors, for several pathogens could be involved. But *Physarium cinereum* is the most common slime mold in turfgrasses.

Life Cycle

Inactive or dormant periods in the life cycle of slime mold are spent as spores. When temperatures warm to at least 60°F and there is an ample amount of moisture, life processes start. Spores absorb moisture until their cell walls finally break open and give rise to new swarming type spores. These spores then join together and develop into even more mobile forms that eventually produce a water-like substance called plasmodium. The plasmodium is actually capable of a primitive amoeba-like movement, and it is in this stage that slime mold creeps up and over grass plants. As the slimy material dries, it becomes the ashen, powdery structures that coat leaves and blades. With proper drying, these become the spores that are carried by wind to new places of infestation.

Southern Blight

Sclerotium rolfsii

Host Grasses
All cool season grasses

Southern blight damage on a golf course fairway

This turf disease occurs infrequently, but does have the capability of causing serious injury. Although it invades cool season grasses and particularly *Poa annua*, it has been a problem primarily in warmer regions of the country.

Southern blight was first observed in Georgia on tall fescue and annual ryegrass during 1950. Later it was found in the Carolinas and more recently has appeared quite often as a serious pest in California. *Sclerotium rolfsii*, the pathogen that causes southern blight, is a common fungi in agricultural crops and frequently its appearance in turf occurs on land that was formerly restricted to agricultural use. In California, it can also cause extreme injury in dichondra lawns.

In the past, southern blight has occasionally been incorrectly identified as Fusarium blight. The two diseases are quite similar in appearance, but the presence of tiny brown sclerotia in the mycelium of diseased turf quickly identifies southern blight.

Symptoms

Injury caused by southern blight first appears during extended periods of hot, humid weather. The infections are circular or crescent shaped and vary in size from only a few inches to more than a yard in width. Turf within the blighted area can turn white to gray-white with threads of mycelium growing at the base of infected plants. Mycelium continues to grow in the advancing edge of the spreading infection. With close inspection, tiny, hard sclerotia varying in shades from yellow to brown can be found among the fungal threads. If conditions favoring the disease persist, blighting of turf spreads, circular infections become

Two views of typical patterns of injury

Severe southern blight injury on a bentgrass putting green

more numerous and eventually coalesce to form large patterns of injury. Tufts of living grass plants may or may not remain growing in the centers of the diseased circles.

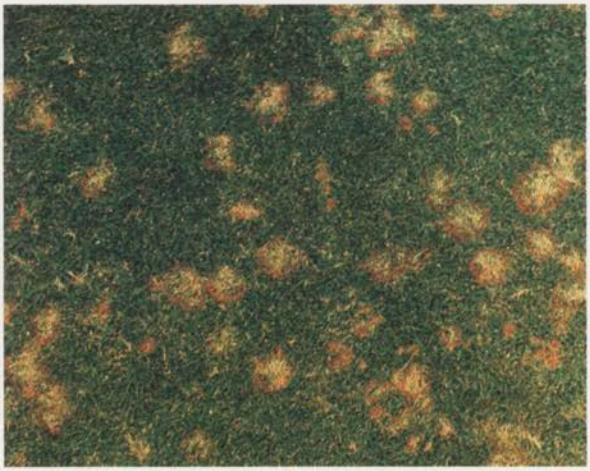
Dead turf within the infection turns brown and often becomes full of unsightly weeds. Southern blight appears in many turf situations, but it's probably observed as more of a problem on well-manicured golf course greens, tees and fairways. It is particularly troublesome in situations of heavy thatch.

Life Cycle

Since southern blight has become a problem only within recent years and in limited areas, its life cycle has not been clearly defined. The sclerotia are most likely to be the primary means for the disease to survive during dormant seasons. Other means of reproduction have not actually been determined.

Copper Spot

Gloeocercospora sorghi



Copper spots are tinged with copper-colored spore masses

Host Grasses
Bentgrass

Although rated as a turfgrass disease of minor importance, copper spot is capable of causing significant damage. It occurs in most areas where bentgrasses grow, but it can become a particular problem in coastal regions. Under proper conditions, it can spread rapidly and reach epidemic proportions in a short time.

If copper spot is rated as unimportant, it may be because it bears such a striking resemblance to dollar spot. They often appear together and copper spot could easily be misidentified as dollar spot, because the latter is much more common and widespread. Fortunately, they both respond to the same controls.

Copper spot gets its name from the color of the infection, which is produced by tiny spore masses. When a white cloth is rubbed across the infection, it assumes a copper color.

Symptoms

The disease first appears on bentgrass as small reddish lesions. They quickly grow larger and eventually cover the entire leaf. As the infection increases, small patches of off-colored turf appear. They range in size from one to three inches and have a pink to copper-colored tint. The tiny spore masses, which give the disease its color, are brighter in wet weather and form a gelatinous covering on the infected grass blades.

If warm, wet weather persists, spots become more numerous, run together and eventually destroy large sections of turf.

Life Cycle

The fungus survives as sclerotia in the debris of previously infected turf. It develops into an active disease when temperatures reach 70°F or above, and the turf and atmosphere are heavy with moisture. With increasing temperature and adequate moisture, the disease spreads rapidly. Spores are splashed or carried to new sites of infection and can form lesions within 24 hours.

Diseases of late summer and fall

Powdery Mildew

Erysiphe graminis

Primary Host
Kentucky bluegrass

Powdery mildew mycelium on a bluegrass blade

In the maintenance of fine turf, powdery mildew is often regarded as no more than an unsightly nuisance. Its whitish cast can cover grass blades in increasing amounts for an entire growing season, but the lack of thrifty appearance is seldom associated with the infection. Like the leaf spot diseases, powdery mildew just isn't dramatic or spectacular, and therefore it is often ignored. But, its mere presence is indication that there is an imbalance in the turf's environment and continuation of this condition can only lead to deeper problems.

Powdery mildew is most damaging in shady, protected areas where there is very little sunlight and poor air circulation. These surroundings are most likely to occur in home lawns where trees, shrubs and the house itself contribute to difficult growing conditions for turf. Many times the mere trimming of trees will allow enough sunlight and beneficial breezes to remedy the problem. In other situations, only major changes can save the turf and quite often ground covers or other alternate solutions are more practical.

Powdery mildews of various varieties attack nearly all agricultural crops and many grasses, but some cultivars of Kentucky bluegrass are especially susceptible. Infection seldom starts before late spring and, since it thrives in dry weather, it can increase progressively through summer and into fall. Although it does not develop a root rot phase, plants can become thinned and weakened.

Those plants that are not lost during the growing season move into winter in an extremely weakened condition. The resultant loss can be blamed on many logical causes but very seldom powdery mildew.

Heavy infestation of powdery mildew on bluegrass

Thinning of turf by powdery mildew in deep shade

Symptoms

Turf infected with powdery mildew is a dull gray-white and at first glance appears to be covered with dried soapy water. Closer examination reveals the presence of a very fine cottony mycelium on the upper surface of the blades. Older blades are most susceptible to infection and, if the disease persists, they gradually fade to pale yellow and eventually wither and die. As plants lose their ability to function properly, turf slowly becomes thin and open.

Life Cycle

Powdery mildew overwinters as unique reproductive spores in sack-like enclosures. These structures are hidden in the debris of the previous season's infestation. Dormant mycelium in plant tissue can also aid a new outbreak. In the spring, when conditions are favorable, spores are carried by wind to plant leaves. They germinate in a very few hours and develop appendages that penetrate the leaf surface. Heavy fungus mycelium on the leaf results from a high population of infecting spores and additional spores produced by the pathogen's reproductive process. Microscopic sacks of spores are produced in the fall to help insure disease preservation for another year.

Rust

Puccinia spp.

Host Grasses
All grasses

Close up views of rust pustules on Kentucky bluegrass blades

In most instances, the presence of rust is considered as only a minor annoyance. Even though grass blades are flicked with orange and slightly discolored, there is little concern, for the disease generally disappears with a change in the weather, or fertilization. Many times this is true, but a neglected rust problem that lingers for days can often result in the loss of good turf.

There are a number of rust fungi that are capable of attacking many turf grasses. In western parts of the country, stripe rust has the potential for causing exceptional turf injury in Kentucky bluegrass. It is also a threat to the seed fields of the Pacific Northwest. Bermudagrass rust can cause discoloration in certain improved varieties, while zoysia rust can cause severe thinning. Crown rust, which is common in perennial ryegrass, also attacks tall fescue.

The most common rust fungi is stem rust and it invades stands of Kentucky bluegrass across the United States and Canada. It is a disease of later summer and early fall, when days are warm, nights are cool and grass is growing slowly. In California it, often lingers throughout the winter. Improved cultivars with fine texture and good color, which have a strong resistance to leaf spot, are often the most susceptible to this type of rust.

Symptoms

Rust seldom becomes a problem until the grass stops vigorous, active summer growth. This generally occurs after an extended dry period.

The disease is first observed as tiny, yellow spots or lesions on the surface of the blade. As these lesions enlarge, they become slightly elongated and

This infestation of rust appeared at the end of summer when fertility levels were low

eventually rupture to reveal tiny clusters or pustules of rusty-orange spores. When these pustules become numerous, they appear to be arranged roughly in rows, as they follow the veination of the leaf. The emerging pustules are surrounded by a ring of pale yellow leaf tissue. If the disease persists and becomes more severe, grass blades turn yellow from the tip of the blade back toward the sheath. On hot days, the blades fold as if suffering from the effects of drought. Eventually, the infected blade shrivels and dies.

The rusty spores are crushed like powder between the fingers and leave a discoloration on all they touch. Moist surfaces of disease-free grass blades can be touched by the spores and show signs of a new infection within 10 to 14 days.

Life Cycle

The rust diseases of turfgrasses have separate, unique and complex life cycles. Most go through five distinct spore stages and some of these stages occur on different host plants. *Puccinia graminis* produces spores in two phases in the thorny barberry plant. These spores are carried to bluegrass where they infect the leaves and develop additional fungus reproductive structures.

In southern parts of the bluegrass belt, the fungus can overwinter as dormant mycelium and as thick-coated spores. When warm weather arrives, the spores are carried into cooler areas by winds. They land on healthy grass plants, invade the healthy tissue and start a new cycle. The complexity of the rust life cycle helps to assure the survival of the fungus.

Yellow Tuft

Downy Mildew, Crazy Top
Sclerophthora macrospora

Unusual growth of bentgrass infected with yellow tuft

Severe infestation of yellow tuft in Kentucky bluegrass

Host Grasses
Creeping bentgrass,
Velvet bentgrass,
Colonial bentgrass,
Kentucky bluegrass,
Poa annua,
Tall fescue
Perennial ryegrass,
Poa trivialis
St. Augustinegrass

Yellow tuft is considered to be primarily a nuisance disease, although there are occasional reports of severe injury. It can affect nearly all cool season grasses, but is a particular problem on closely mowed bentgrass and bluegrass. There is a natural resistance to infection among certain varieties.

Yellow tuft becomes a problem in the warm, moist weather of spring and fall. Turf that lies in low, wet areas, or areas of poor drainage seem to be most heavily affected.

Symptoms

The infection is first observed as small yellow spots in otherwise healthy turf. These spots may range from a fraction of an inch to several inches in diameter. Close inspection reveal an unnatural or excessive chlorotic shoot growth in the infected areas. Symptoms seem to decrease and disappear during hot, dry summer weather. Yellow tuft in turf is identical to downy mildew *(Sclerophthora macrospora)*, a disease that causes "crazy top" in corn and "proliferation" disease in sugar cane.

For years yellow tuft was believed to have been caused by the activity of parasitic nematodes.

Life Cycle

Yellow tuft overwinters as mycelium and other immature stages of the fungus in infected parts of the plant and in debris. It becomes active in the warm, moist weather of spring.

Regional diseases

Gray Leaf Spot

Piricularia grisea

Primary Host
St. Augustinegrass

Many gray leaf spot lesions on a St. Augustinegrass blade

Although gray leaf spot can infect a number of turf grasses, it is primarily a problem of St. Augustinegrass. It is a disease which follows the St. Augustine growing zones from southern Florida around the Gulf Coast into Texas, and also the St. Augustine lawns of southern California.

Gray leaf spot is a summer disease that becomes particularly active during extended periods of hot, humid weather. Most turf diseases are especially injurious on tightly knit grasses, but gray leaf spot thrives on sparse, thin stands of St. Augustine. For this reason, newly sprigged lawns are more susceptible to damage than established turf. Sprinkling, which is necessary to start new turf, is generally blamed for splashing spores from the soil to healthy plants.

Gray leaf spot is not considered to be a highly destructive disease, and during the summer season, it is almost always present in varying degrees. When lesions become numerous, the turf often looks like it cannot survive. The elongated spots not only cover the leaves, but also sheaths, stems and seed stalks. But only in rare instances of prolonged neglect is the turf ever permanently damaged.

Symptoms

When the atmosphere is saturated with moisture, and temperatures remain consistently in the 70°F to 80°F range, gray leaf spot becomes evident. Lesions first appear as tiny brown spots and rapidly enlarge to become oval. The oval spots eventually become elongated, with depressed grayish-tan centers. Lesions are bordered by a brown margin, and the brown margin is surrounded by a band of chlorotic,

Magnification of gray leaf spot lesions

Healthy St. Augustine on the left
gray leaf spot infection on the right

yellow-green tissue. During peak disease activity, a gray mold-like growth often covers the blades.

As the disease becomes more obvious, lesions can be found on sheaths, stems and seeding spikes. Lesions on leaves, sheaths, and spikes are very similar, while those on stems are dark brown, or almost black. During severe attacks, plants take on a withered, dried, or scorched appearance, which is quite often mistaken for drought damage.

Life Cycle

Piricularia grisea, the pathogen in gray leaf spot disease, overwinters as inactive mycelium and spores. These are found in the sheaths and lower leaves of infected plants and in the thatch from previous infections. When temperatures reach 70°F and there is sufficient atmospheric moisture, a new infection can start. If temperatures remain consistently in the 70°F to 80°F range, gray leaf spot can spread rapidly. Spores are carried by the wind, or splashed by rain and irrigation water to sites of new infection. As spores come to rest on the leaves of healthy plants, they form appendages which penetrate the surface of the leaf and continue the parasitic chain.

St. Augustine Decline (SAD)

Healthy St. Augustine leaves on the left, with SAD infected leaves on the right

A St. Augustine plant infected with SAD virus

Host Grasses
St. Augustinegrass

SAD is one of the few identified turf diseases caused by a virus. It infects St. Augustinegrass around the Gulf Coast from southern Florida through Texas, and over the past several decades it has been responsible for an uncalculated amount of damage. There are no curative or preventative chemical treatments, and thus far the fight against SAD has been dependent upon the development of resistant strains of St. Augustinegrass.

SAD is first observed as mottling of the leaves. It has been further described as spotting or speckling, and is sometimes mistaken as a nutritional deficiency. During the second year of infection, the mottling increases and the blades become chlorotic. Growth is very slow and the turf starts to become weedy.

The virus is quickly transmitted from place to place by clippings, and can easily be brought into a new neighborhood by the addition of plugs or sod. Lawn care services that practice mowing and dethatching can readily spread the disease from one place to another.

Like other turf diseases, infection becomes more severe where the turf is already in a state of stress. This can be caused by a lack of moisture, poor nutrition, nematodes or other similar causes. But regardless of the health of the lawn, if it is a susceptible variety of St. Augustinegrass, it will be infected.

Turfgrass insects

Introduction to Insects

Insects are by far the most populus form of animal life on earth. They have evolved and adapted to a changing environment through 300 million years of existence. Man, on the other hand, is practically a new arrival with only a million years of life. The exact number of insect species can only be estimated at near 1 million and within some species numbers may be high as a billion. The presence of a few thousand insects on a home lawn sounds alarming, but in most instances, this is a population well within acceptable limitations.

In any discussion of insects, there are always the inevitable statistics and dire predictions about all the damage they can cause. Each year insects destroy billions of dollars worth of agricultural crops. They spread disease, eat away the foundations of our homes, sting, bite and cause enormous discomfort in an incalculable number of ways. Insects can be so objectionable that it's difficult for us to believe that they could bring mankind any kind of good. But, there are many beneficial insects and insects that serve a special purpose. Without them there would be no pollination of flowers. Many agricultural crops and a large number of fruits and vegetables would fade from the earth. Birds, fish and animals would lack food, and life as we now know it would cease to exist.

When we consider the vast hordes of insects on the face of the earth, the number of turfgrass destroying insects is astonishingly insignificant. It has been estimated that approximately 60 species of insects may at some time become potential problems in turfgrass. Of these 60 species, less

than half are consistent, predictable turfgrass pests. Even though few species are involved, it doesn't diminish the possibility for devastating injury. A single species can be present in excessive numbers and cause an unbelievable amount of damage.

The appearance of turfgrass insects can be somewhat cyclical, but whether they appear in damaging numbers also depends on a great many external factors. Weather is extremely important and plays a very significant role. It has a decided effect on reproduction, survival and the activity of offspring. Predators are another way of keeping insect populations in check. But when there is an interruption or disturbance in the activity of predators, some species may multiply to excessive numbers. Unless the insect has a favorable food supply, its numbers seldom become oppressive. Some insects can produce many generations and an astronomical count of offspring during a single growing season. Because nature inflicts so many external forces, only rarely do they appear in excessive infestations.

Unlike the various turfgrass diseases, injury from insects is many times completely lacking in pattern. When many insects are present, grass can turn off color, be chewed to the crown, wilted, or merely unthrifty. Frequently, populations can become unusually high before any form of turf injury becomes apparent. But, even with excessive numbers, insects can move so rapidly they are often difficult to actually detect. Combinations of heavy insect infestations and attack by turfgrass disease are not unusual and many times very destructive. In some forms of insect injury, turf will recover and in other instances, only seeding and sodding can repair the damage.

Certain varieties of turfgrasses show remarkable resistance and tolerance to heavy infestation of insects. When these pests become a potential problem year after year, then resistant varieties become viable alternatives to continued injury. In most instances good turf management is the best means of preventing insects. Keeping the grass healthy by avoiding heavy accumulations of thatch and unusual levels of lushness are very important. As in the prevention of turfgrass diseases, the important factor is to avoid the excesses. Fertilize properly, but never excessively. Water properly, but never excessively. By keeping the turf vigorous and growing properly, it can better resist infestation and injury by insects. On those rare occasions when these pests appear in unusual numbers, early detection and identification will aid in ultimate treatment and control.

As an aid to identification, turfgrass insects have been divided into three groups. The first group is composed of insects that live in the soil. They destroy the grass plants ability to take up nutrients and moisture by

devouring, destroying or sucking away fluids from the roots. Included in this group are ground pearls and the many white grub species. The second group is formed by those insects that live in thatch. Typical members of this group are sod webworms that destroy by chewing crowns or foliage and chinch bugs that suck away plant juices. The third group includes insects that live and feed on stems and leaves. Good examples of this group are the greenbug and the scale insects.

The Insects

To many people an insect is simply any little bug that creeps or crawls. Most of us think of spiders as insects, but they are actually in a group within a large classification called arthropods. Centipedes, millipedes, ticks and mites also fall into categories within this classification. Classifying a form of animal life as a true insect requires the recognition of a very unique and specific body structure. Unfortunately, most turfgrass literature is not strictly precise or formal, and pests, such as the harmful mites, are almost always listed with the insects.

An insect's body is segmented, elongated, and composed of three sections: the head; the thorax, and the abdomen. The head contains eyes, the antennae or "feelers" and the mouth parts. Insects generally have two kinds of eyes, simple and compound. The simple eyes, or ocelli, are located on the front of the head and are so small they are often overlooked. Some insects have only two and some have none. The large compound eyes are most easily observed and composed of many hundreds of facets. Antennae are located at the front of the head and vary greatly in form, shape and prominence. Mouth parts are usually located on the lower part of the head. They are highly complex, variable and the two primary types are chewing and sucking.

The body segment adjoining the head is the thorax, or middle body. It anchors the insects three pair of legs and, when they are present, the

wings. Legs vary in size and shape, but have the same basic structure. Wings are also variable in size, shape, texture and the venation is frequently used in classification and identification.

The abdomen or rear section of the insect's body contains the digestive, reproductive and excretory organs. The sex of many insects can be determined by parts of the abdomen.

Insects have no lungs, no internal skeleton and no backbone. They breathe through tiny holes along the body. Air enters these holes and is distributed to the body through tiny air tubes. The outer body is covered with a tough material called "chitin." It envelopes the insect like a coat of armor and forms an outside skeleton. This outer shell is shed frequently and replaced by a new and larger one. It's a process called molting and generally occurs from four to eight times. Most insects stop molting and do not increase in size after reaching the adult stage.

Insects are very complex, unique forms of animal life. Some can easily crawl through the eye of a needle, while others may reach six or eight inches in length. Turfgrass insects seem to be a good representative cross section of the insect family. Even though they feed on grass plants, they are quite diverse in a number of other ways. Many orders, genera and species are represented.

Insects that live in soil

Ants

(Family Formicidae)

Fire ant

Carpenter ant

Injury to turf caused by the cutter ant

Since ancient times, the ant has been proclaimed for its persistence, boundless energy and almost superior intelligence. But, ant colonies, with queens, guards, hunters and other specialists, function on little more than instinct and hormones. If there are complaints, arguments and discord, we humans will never know, for all we see is complete dedication to the task at hand. The queen is not only the pampered founder of the colony, she stays on for 10 to 15 years to insure its perpetuation and expansion into new areas.

In turf, ant hills disfigure and suffocate, but, below ground plants are torn from their moorings as roots are pushed, shoved and severed. Air that passes through these openings causes abnormal drying and additional stress. These are the typical and obvious problems with ants, but there are others.

The harvester ant feeds on seed and can harm new seedings by stealing the seed, or feeding on it before it germinates. In the south, the fire ant continues to spread into new territories. Fire ants would not be a problem if mounds were their only disturbance, but they have a sting that is akin to being lanced with a red hot needle.

The cornfield ant has such a keen appetite for the "honeydew" excretions of the corn root aphid, that it acts as the aphids constant host and protector. Before corn is planted in the spring, the ant carries his little charge to the roots of the knotweed for feeding. When the corn starts growing, he moves the aphid back to the corn.

In southern states, leaf cutter ants cut paths through turf and then defoliate trees for their food. Ants are universal and the most abundant insect on earth. They lead a fascinating, structured community life, with workers, farmers, slaves and pets, but there is no place for the ant in good turf.

Billbugs

(Sphenophorus spp.)

Adult bluegrass billbug

Billbug injury to a bluegrass lawn

Bluegrass billbug larva

Billbugs are quite common as pests of agricultural crops and a number of species are particularly harmful to turfgrasses. In the Southwest, the phoenix billbug can be highly destructive to the bermudagrasses. From the East coast to Kansas, the zoysia billbug is a special problem in zoysiagrasses. Coolor areas of the country are troubled by the bluegrass billbug and its own unique havoc.

The billbug belongs to a fairly large group of insects known as snout beetles. The snout beetle gets its name from a long and homely proboscis, which holds strong chewing parts at its tip. They vary in color from a dingy cream, to brown, to almost black and range in length from ¼ to ½ inch.

Although the adult can cause some injury to turf by chewing, almost all serious damage is caused by the larvae. It is mostly white, ¼ to ⅜ inch in length, legless, with a bright orange-brown head and a blotch of black on its back.

Most species of billbug overwinter in the soil as adults and emerge to feed during the bright, warm days of spring. They chew on grass blades and eventually bore small openings in the crown to deposit eggs. Eggs hatch in less than two weeks and the tiny larvae feed on tissue within the stem. As they feed, they move downward until they finally reach the rootzone. Feeding near the crown, the legless larvae sever the roots so that the entire plants can be effortlessly pulled from the soil. Pupation occurs during mid-summer and adults emerge, feed and re-enter the soil for hibernation before cold weather. In warmer sections of the country, the billbug often overwinters in the pupal stage.

Billbug damage is observed as yellow to brown spots, and a light brown, sawdust-like material can be found in the rootzone area. Heavy populations cause widespread destruction.

Black Turfgrass Ataenius

(Ataenius spretulus)

Black turfgrass ataenius larva

Adult black turfgrass ataenius

A golf course fairway severely injured by ataenius larva

The Ataenius grub was first recorded as a turf pest in 1932, when a golf course in Minnesota became infested. This incident was forgotton until the early 1970s when the insect appeared again. Since then, black turfgrass ataenius has been recognized as a very unique turfgrass pest and capable of extreme destruction. Activity has been most intense on golf course fairways composed of bentgrass and *Poa annua* from the Midwest to eastern parts of the country. Golf courses near the Ohio River have been particularly vulnerable.

First indications of black turfgrass ataenius infestation appear as an off color and wilting of turf. Since this condition occurs during the stress of oppressive midsummer heat, it is most often confused with the "fading out" of *Poa annua.* Insects are seldom suspected until damage has reached unusual proportions and large sections of turf have died. In some situations, populations of ataenius grubs have exceeded 500 per square foot.

When weather has warmed in the spring, the adult beetle moves out of hibernation. It is a shiny, hard shelled little beetle approximately $\frac{3}{8}$ inch in length. Its color at first is a very dark red, but soon turns to a solid black. The head and the forepart of the body are smooth and round, while the wing covers have a series of shiny, longitudinal ridges.

Eggs are laid from early May into June and larvae hatch primarily in June and July. Larvae are white with three pairs of legs and a bright creamy-orange head. Their curved bodies measure about $\frac{3}{8}$ inch in length. They are most active near the soil surface, as they constantly feed on grass roots. When damaged turf is rolled back, adults are often found among the larvae.

During late July and early August, pupation is completed and the adult beetles emerge from the soil. In some areas, such as Ohio, adults again lay eggs in early fall, which hatch and become adults before cold weather. The adults overwinter in fringe areas of taller grasses.

Crane Flies

(Family Tipulidae)

European crane fly

Injury to a lawn in the Pacific Northwest caused by the European crane fly larva

European crane fly larva

The cranefly, or leather jacket, resembles a giant mosquito and has often been used as the model for fly fishing lures. Like the mosquito, the crane fly prefers warm, moist places with abundant vegetation. There are many species and they are common throughout the United States and Canada. The crane fly itself is not known to be destructive, but it produces larvae that feed on many kinds of vegetation and particularly grasses. They become so plentiful in some parts of the country that severe thinning of rangelands is common. In other places, they are destructive to agricultural crops, such as alfalfa and potatoes. As a turfgrass pest, the European crane fly *(Tipula paludosa)* has become particularly troublesome in the Pacific Northwest.

The adult crane fly is dull colored gray-brown, with bulging eyes and a long slender body. It is slightly more than ¾ inch in length, with long, fragile thread-like legs and narrow wings. Egg-laying time for the female crane fly comes during late summer. She deposits several hundred oval black eggs in moist soil and they hatch into larvae by fall. Larvae are legless, dull gray-brown and mature to about an inch in length. During the day they feed on roots and decaying vegetation in the soil and on warm, wet nights they come to the surface to feed. They chew on low-lying leaves and often sever plants at the crown.

Larvae overwinter in the soil and start feeding again when temperatures are moderate in the spring. They cause a severe thinning of turf, which is generally followed by an invasion of weeds. All turf is susceptible to attack, but infestations in new seedings can be especially destructive. Pupation occurs just below the surface of the soil and the adult crane fly emerges by early summer to continue the life cycle.

Invasions of crane fly larvae are highly dependent on weather. When temperatures are high and there is little rain, both eggs and larvae are destroyed and the opportunity for infestation is greatly decreased.

Ground Pearls

(Margarodes meridionalis)

Mature ground pearls cling to grass roots

Initial symptoms of ground pearl injury in centipedegrass

Tiny little insects called ground pearls are sometimes no larger than a grain of sand. They are classified as a scale insect or insects that attach themselves to plants and gradually suck away the plant's essential fluids. Ground pearls are a southern problem, and their habitat ranges from South Carolina westward to California. Although they can cause serious damage in bermudagrass, they are particularly destructive in centipede turf.

Ground pearls and other scale insects have such an unusual system of camouflage that they are seldom recognized as insects. As they fix themselves to the grass plant, they become immobile and secrete various coverings around their bodies. The coverings not only protect the feeding insects, but make them look like a harmless part of the environment. Their piercing mouth parts drain the juices from the plant, and severe injury can be inflicted.

The tiny, round adult female is seldom more than $\frac{1}{16}$ inch across. She deposits approximately one hundred pinkish-white eggs in a white waxy sac. These are found next to her feeding place in the rootzone. Eggs soon hatch into tiny round nymphs or "crawlers," which move about freely and feed on fine hair roots. In a few days they insert their mouth parts into the roots, lose their legs, and begin a stationary existence. At the same time, they secrete the silvery-white substance that soon becomes the hard, gobular shell around their bodies. The adult female can remain in this position, attached to the roots, for two to three years.

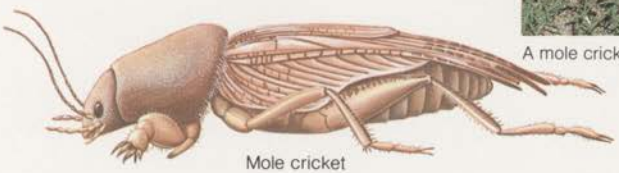
Male ground pearls look very much like small gnats. They have no functional mouth parts and do not damage the turf. While the female remains motionless, the male develops wings and moves about from place to place. His only apparent function is to mate and insure continuance of the life cycle.

Turfgrass infested with ground pearls turns yellowish in irregular patterns. Since centipedegrass is sensitive to nutritional disorders, ground pearls are not always suspected.

Mole Crickets

Southern *(Scapteriscus acletus)*
Changa (Puerto Rican) *(Scapteriscus vicinus)*

A mole cricket mound in bermudagrass



Mole cricket

The mole cricket is primarily a pest of southern turf, ranging from North Carolina through Florida and around the Gulf coast into Texas. It is a major insect problem in bahiagrass and one of the most injurious in bermudagrass. The two species of mole cricket responsible for infestation are the changa or Puerto Rican and the southern. Although the changa is plump, robust and the larger of the two, the southern is more numerous and destructive. In northern Ohio, a temperate mole cricket species, *Gryllotulpa major*, has been reported on putting greens.

Even though the mole cricket chews on grass roots, it causes much more injury in this area with its powerful, tunneling forelegs. As the insect rips and burrows into the soil, it tears plants from their growing places, destroys roots, and pushes mounds of soil above the turf. A single mole cricket may claw and tunnel through more than a dozen feet of turf in a day.

Adult mole crickets have rounded, armor-like bodies, large beady eyes, and they reach a length of nearly 1½ inches. Wings are flattened against their backs, and forelegs are terminated by strong hand-like appendages. The changa is a light creamy brown, while the southern is an orange tinted darker brown. During early spring, the female hollows out egg cells several inches below the soil surface. She deposits up to 35 eggs and may fill three to five cells during the laying season. Egg laying reaches a peak in May and June in most areas, but can be more continuous in milder climates.

Eggs hatch in approximately 2 weeks, while cooler weather can retard hatching up to 35 days. The nymphs grow rapidly and like the adults come to the soil surface at night in search of food. In addition to roots, they feed on organic matter and soil organisms. Feeding activity reaches a peak when temperatures are warm and moisture from rains or irrigation is extremely high. Most mole crickets reach full growth before mid-winter, but later generations overwinter as nymphs. In most regions a single generation is produced each year.

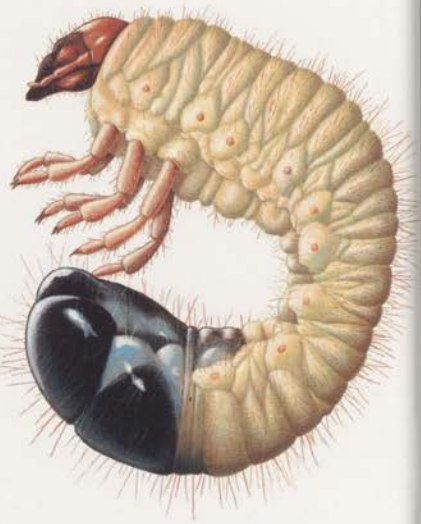
White Grubs

(Family Scarabaeidae)

May beetle

Japanese beetle

Masked chafer



White grub

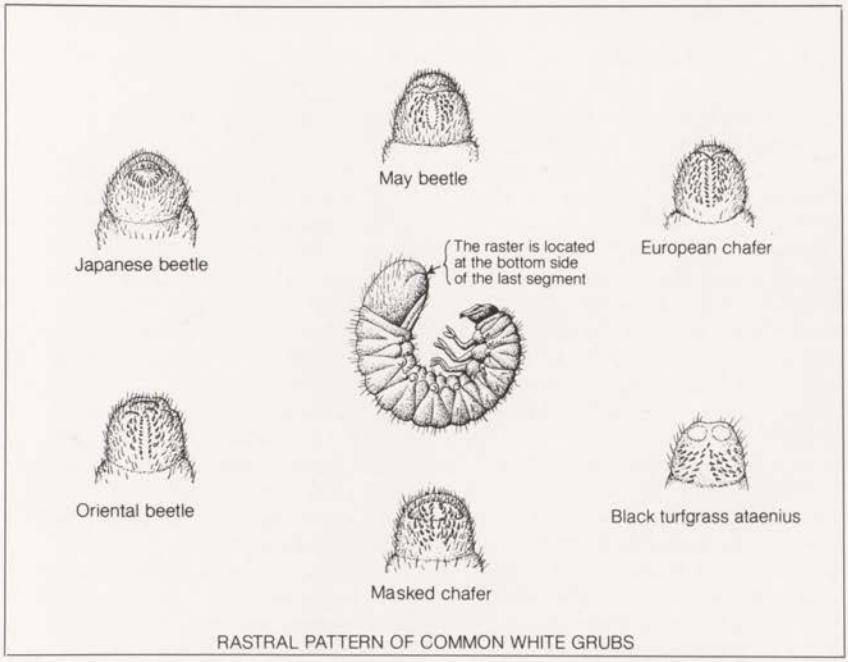
White grubs are the most widely distributed of all turf insects and well over a *hundred species* are involved. Populations are generally much heavier in the eastern half of the United States. The white grub is the larval stage of the May Beetle, June Beetle, Masked Chafer, European Chafer, Japanese Beetle and various other hard shelled beetles. A great part of its life cycle is spent hidden an inch or two beneath the turf where it chews and feeds on grass roots.

The white grub varies in length from ¾ inch to nearly 1½ inches and its color can vary from white to grayish white. It has a bright brown head, three pairs of legs and a soft, curved segmented body. The hind part is smooth, shiny and often darkened by devoured vegetation. The underside of the last abdominal segment, or raster, is used for specific identification of the grub.

Some adult beetles feed on the leaves of trees, shrubs or flowers, while others do not feed at all. Many are nocturnal and because they are attracted to light, they often congregate around street lights and well lit windows. The Japanese Beetle is an exception to the night active species, as it spends the middle of the day feeding on ornamental foliage and other vegetation.

Life cycles of the various beetles vary from one to four years and they can also vary from northern to southern parts of the country. From early spring to midsummer, females burrow through the turf into the soil and deposit tiny white eggs. This process is repeated for a number of days until *50 to 60 eggs* have been laid. Eggs start to hatch in 10 to 21 days and the newborn larvae begin feeding on roots immediately. When cold weather returns, the grubs burrow deeper into the soil to hibernate. As soil warms again the following spring, they resume feeding for a short time, then change into pupa and eventually adults. For grub species with life cycles of more than a single year, the larvae feed for several seasons before pupating.

White grubs destroyed this turf in late fall



RASTRAL PATTERN OF COMMON WHITE GRUBS

Wireworms

(Family Elateridae)

Wireworm

Click beetle

The many species of wireworms have a reputation for causing an incalculable amount of injury in agricultural crops. They feed on roots and cause poor production in crops like wheat, corn and cotton. By chewing and boring through potatoes, carrots and sugar beets, they can make an entire harvest unsalable. In turf, the wireworm destroys roots and rhizomes, causing grass to die in small irregular patches. They can cause particular destruction in new seedings and occur in all parts of the country.

Wireworms are the larval stage of "click beetles." These little insects are awkward and occasionally tumble over onto their backs. They rest in this position for a moment, then flip themselves a few inches into the air with the intent of landing on their feet. When they miss, they rest and then try again. Each flip is accompanied by a crisp "click," which gives the beetle its name.

The brown to almost black click beetle lays eggs in spring and early summer and the eggs hatch in two to four weeks. The shiny, hard bodied worms are yellow to orange-brown in color and when they reach maturity, their length may vary from ½ to 1½ inches. They have three pairs of legs which are located near the head. The wireworm remains in this larval form from two to six years before they eventually pupate and evolve into click beetles. It is not unusual for the adult click beetle to overwinter in the soil.

Despite their destructive habits, wireworms are said to do some good by acting as predators on other soil-borne pests. It's not a measurable quality, but they are known to move through the soil and destroy white grubs.

Wireworms are tough, active, destructive pests. They prefer to feed on the roots of vegetables and farm crops, but on some occasions, they become concentrated in turf. Even though they aren't classified as a highly specific turfgrass pest, in high numbers they are capable of causing much turfgrass injury.

Insects that live in thatch

Chinch Bugs

(Blissus spp.)

Adult chinch bug

Chinch bugs have caused extensive damage to this bermudagrass lawn

The nymph and two immature stages of the chinch bug

Chinch bugs can be a problem on turfgrass throughout much of the country; however, they are constantly more damaging in the Midwest, East and South. In temperate regions, injury can be particularly severe on bluegrass and bentgrass, while St. Augustinegrass is highly susceptible in the South. Chinch bugs are so small and inconspicuous that they can literally destroy a lawn without ever being actually observed.

Chinch bugs become active when temperatures are in the high 70s and activity reaches a peak during extended periods of hot, dry weather. The chinch bug inserts its slender beak into the grass plant, extracts fluids and is suspected of injecting a toxic substance. Activity often starts near the reflected heat of walks and streets but soon spreads outward into healthy turf. As the grass turns from pale yellow to a lifeless tan, it is most often confused with drought and injury can be extensive.

Females start laying eggs in late spring and normally deposit over 200 eggs during a 20- to 30-day period. Eggs are laid in the sheaths of grass plants, or other protected places and they hatch in 7 to 10 days. The tiny red nymphs are wingless and have a white to pale yellow band across their backs. They are extremely active, have strong appetites and start feeding immediately. As they grow older, their color gradually becomes darker and depending on temperature, they become adults in about 5 weeks. The adult chinch bug has a black body that measures about ⅕ of an inch in length and a black triangular pad separates white, folded wings. Most of the chinch bug's mobility comes from scampering through the grass, although it is capable of short flight.

Two or more generations can be produced in a growing season. First generations often complete their life cycles before the first frost. Succeeding generations hibernate in the thatch and upper parts of the soil. In southern climates, the chinch bug may continue to remain partially active throughout the winter.

Cutworms

(Family Noctuidae)

Cutworm injury to a golf green

Black cutworm adult

Black cutworm

Most cutworms have ravenous appetites and are notorious as foliage feeders. Many a farmer has witnessed the destruction of a corn crop as cutworms systematically severed the tiny plants at the soil surface. While cutworms can cause exceptional injury in turf, in most instances they are rated as only a minor nuisance. When severe injury does occur, it is generally because high populations have exhausted their food supply and are moving toward a new feeding place.

Cutworms have smooth, round, segmented bodies that vary in length from 1 to 2 inches. Like sod webworms and armyworms, they have three pairs of legs with additional prolegs, or unjointed projections on the abdomen. Their colors are uniquely dull and inconspicuous shades of brown, to gray, to black. They do most of their destructive feeding at night and spend the days curled and hidden under weeds, rocks, leaves, or anything that serves as a shady cover.

Adult cutworms are moths with wings of indistinctive tan to gray and marked with lighter or darker patterns of spots and bands. Forewings are larger and darker than the hind wings. When the moths are at rest, wings are folded over their bodies. Moths remain inactive during daylight hours and become quite active in the evening. Like many other insects, they are attracted to light after dark and often gather around well-lit windows, or other bright places.

During its life cycle, each moth may deposit several hundred eggs in grassy areas and weedy fields. Eggs hatch in about a week, and depending upon the species and locality, cutworms may produce one to four generations per year. Because of the mild climate, southern areas are most likely to produce multiple generations.

After the cutworm becomes full grown, it burrows a tunnel into the soil, forms a cell and enters the pupal stage. Eventually, the adult moth emerges from the tunnel and repeats its life cycle. Nearly all species of cutworms spend cold weather as immature larvae, or pupae in the soil.

Fall Armyworm

(Spodoptera frugiperda)

Fall armyworm adult

Fall armyworm

The pattern of fall armyworm destruction

The fall armyworm* is primarily a southern insect that extends its range of activities into northern regions. It is a potential problem as far north as the Ohio Valley, eastward to southern New England and westward to the northern edge of the Rockies. As the name indicates, fall armyworms are capable of appearing in great masses and migrating like an army to better feeding places.

The fall armyworm is the larval stage of dull gray-brown moths that hide during bright daylight and then become quite active during the evening. Moths have a wingspread of about 1½ inches and dark forewings mottled with patterns of light and dark spots. They lay eggs in masses of a hundred or more on the leaves of grass, or other foliage. Tiny larvae hatch in about a week and within three weeks become full grown fall armyworms. Color varies from light green to brownish-black, with several stripes along the sides. They reach a length of approximately 1½ inches and a light cream colored inverted "Y" covers a shiney brown head. Sparse, long hairs arise from tubercles along the length of the body. Three pairs of legs are arranged near the head and four pairs of stump-like prolegs are found toward the rear of the body.

Chewing along the edges of grass blades, the fall armyworm skeletonizes the grass and gives it an overall ragged appearance. In severe infestations, the grass can almost be chewed to the bare ground. Shortly after the larvae reach maturity, they tunnel several inches into the soil and start pupation which takes about ten days.

In northern areas, the fall armyworm produces one generation per year and in the south five or more. Excessive populations in northern areas result from the moths ability to migrate for many miles.

*There are several species of armyworms. The true armyworm *(Pseudaletia unipuncta)* looks very much like the fall armyworm, but lacks the inverted "Y," which appears on the head. It is found less frequently in turf, but can be extremely destructive when present.

Fiery Skipper

(Hylephia phylaeus)

Fiery skipper larva

Fiery skipper adult

There are over two hundred species of skipper moths scattered across the United States. Skippers are so named because of a very erratic flight pattern, which makes them appear to be skipping across the surface of the ground. The fiery skipper, like other skippers, is a stout bodied butterfly with a wingspan of approximately one inch. Males have orange-yellow tinted wings spotted with black, while the female is a dull, dark brown with orange-yellow spots. They are native to many western states, particularly California. The larvae of this butterfly feed on most grasses and though classified as only occasionally injurious, under certain conditions, it is capable of causing fairly extensive damage.

During warm months of spring, the fiery skipper starts to lay eggs in grass and nearby ornamental plants. Eggs soon hatch into tiny yellow-brown larvae. Larvae have an unusual appearance with a constriction, or what appears to be a collar, immediately behind the head. This collar is formed by the first two segments of the body, which are smaller than the head. When the larvae become full grown, they reach a length of about one inch.

Injury to the turf first appears as isolated, small, round spots. Grass within these spots can be chewed to the soil surface. If many larvae are present, injury becomes more severe. Spots become numerous and eventually start running together. In some instances, damage can be so drastic that a turf area can be essentially ruined. Fiery skippers often produce several generations during each growing season.

The fiery skipper larvae can become a problem in all turf grasses. It does seem to have a preference for bentgrass, and bentgrass is most readily injured.

Frit Fly

(Oscinella frit)

Adult frit fly

While not considered to be a major turf pest, the frit fly can become injurious during those occasional years when their numbers become excessive. Known primarily as a pest of cereal grains such as oats and wheat, it can become a problem on practically all low cut grasses. It is a frequent pest of bluegrass, but can also cause unusual trouble on the manicured bentgrass of golf course greens. As this tiny gnat-like insect hovers above the turf, it is generally disregarded as little more than a pesky nuisance.

The adult frit fly with its black, shiny body measures slightly more than $1/16$ inch in length. In temperate climates it emerges from the pupa in early spring and shortly afterwards starts laying eggs. Eggs are white, oval shaped, less than $1/32$ inch in length, with a finely ridged surface. They are deposited under the sheath, in the axils of leaves and hidden in other inconspicuous places on the grass plant. Tiny yellow larvae, with black chewing parts, hatch in a very few days. When they reach full growth, they are only about $1/8$ inch in length. Larvae cause injury to the grass plant by feeding in a tunneling, burrowing path downward through the stems. When feeding reaches the crown, tops of the grass plants become discolored, wilted and eventually lifeless. The life cycle can vary from three weeks to nearly two months. In the Midwest at least four generations occur each year, while various stages of reproduction can be found all year in the South and in southern California.

Extreme injury caused by the frit fly is rare and has been limited primarily to golf greens. It starts with a discoloration in the taller grass of the collar surrounding the green and particularly on the high, or elevated side. If the infestation continues, permanent damage can result as discoloration spreads downward toward the center of the green. Finding the destructive larvae can be difficult and requires the use of a magnifying glass.

Hyperodes Weevil

(Hyperodes spp)

Hyperodes larva

Adult Hyperodes weevil

Hyperodes larva destroying *Poa annua* on a golf green

The Hyperodes weevil belongs to the large "snout beetle" family, which is composed of over three thousand species. It is a very unique pest of several Northeastern states.

The tiny Hyperodes feeds on clover, certain weeds and other vegetation, but has a decided preference for very low cut *Poa annua.* Consequently, it has become a particular pest on golf courses and adults can often be seen crawling on the turf from early spring until late fall.

In the adult stage the Hyperodes is very small and measures only about $3/16$ inch in length. Color varies from brownish-black to shiny black and its long chewing snout stretches ahead of its body. It feeds by chewing along the edge of grass blades and damage to turf in this stage is generally very minor.

Adult females eventually deposit microscopic sized eggs in the sheaths of grass plants. Larvae that hatch from these eggs are also nearly microscopic. They live and feed within the stems and eat downward toward the crown. Leaves turn yellow as stems are destroyed and eventually the entire plant dies. This forms yellow brown spots in the turf and these spots can soon coalesce into large dead areas. Injury to turf becomes evident and most severe on the edge of golf course greens, tees and fairways.

The tiny larvae soon work their way through the grass plant and into the soil. By this time, they have grown to a length of $3/16$ inch. Their curved bodies are cream colored, legless and topped by a bright, shiny, black head. Shortly after reaching the soil, larvae start pupation. Pupae are also cream colored and can be found $1/4$ to $3/4$ inch below the soil surface. In slightly over one week, pupation ends and the new adult is ready to emerge from the soil.

Severe injury from Hyperodes generally occurs in May or June and before hot weather, but it is still mistakenly identified as the age old problem of *Poa annua* fading out. It has been generally determined that two generations are produced during a growing season.

Sod Webworms

(Family Pyralidae)

Sod webworm

This home lawn was severely damaged before sod webworms were discovered

Sod webworm adult

There are many species of sod webworms and one or more can occur in every section of the country. In eastern states, the bluegrass sod webworm is predominant, while the tropical sod webworm is the prime species in Florida. California has two webworms of equal importance.

The sod webworm is the larval stage of the tan or buff-colored lawn moth. Lawn moths are commonly seen in the early morning flitting above the turf in short zigzag patterns. As the moths fly, they drop eggs which hatch into larvae in just 6 to 10 days. The tiny larvae start feeding on grass blades and building silk-lined tunnels in thatch and debris near the soil surface. Sod webworms are nocturnal insects, so they chew and feed at night and remain hidden during the daylight hours. They feed on tender parts of the grass, and as they grow, their appetites increase. Soon entire plants can be destroyed and irregular patches of dead turf appear.

When mature, the sod webworm reaches a length of about ¾ inch. It is a dingy dull, tannish-brown, but occasionally some species take on a greenish cast. Long, stiff hairs protrude from brownish-black circular spots that are spaced along the sides and back. The head is a dark, shiny brown.

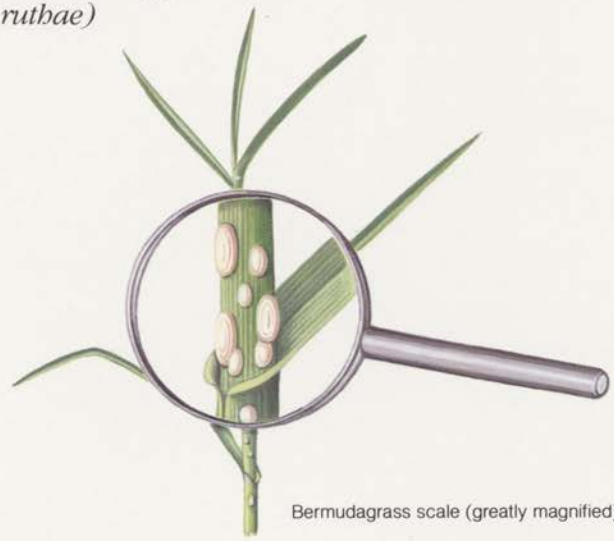
The sod webworm is elusive and often evades detection, but many birds on the turf are a good indicator. The birds probe the dying turf with their beaks and leave behind a pattern of holes about the diameter of a pencil. Another sure sign of sod webworms is the material called frass. These greenish, coarse sawdust-like particles are formed by the webworm as it chews and feeds on the grass.

Sod webworms eventually evolve into a brown, shiny pupal stage, which is spent in crevices or cells in the soil. They emerge as adult moths only during warm summer weather. Winter months are spent in the larval stage, burrowed and hidden in silk lined tunnels. In tropical areas, sod webworms can produce several generations per year.

Insects that live on stems and leaves

Bermudagrass Scale

(Odonaspis ruthae)



Bermudagrass scale (greatly magnified)

Although the turfgrass scale insects bear little resemblance to each other, they have similar life cycles. The bermudagrass scale, which is sometimes called Ruth's scale, is a pest wherever bermudagrass is grown. It seldom causes extreme damage, but it can sap the strength from turf and prevent if from reaching acceptable performance. The bermudagrass scale is particularly injurious when the grass is suffering through a period of stress.

Adult bermudagrass scales are about $\frac{1}{16}$ inch in length. They are covered with a hard white secretion which is round or clam shaped. These tiny clam-shaped formations are found on the stems of grass plants, around nodes and only occasionally on the leaves. In a casual observation, the whitish substance formed by the scales looks very much like a powdery mold. Only closer examination with a hand lens will clearly reveal clusters of the tiny, white, clam-shaped insects.

Females lay eggs under the clam-shaped covering and in a very few days the nymphs, or "crawlers" hatch. They are nearly microscopic, but move among the grass plants and spread the infestation to new places. Soon they find a suitable place to feed and inject their piercing mouth parts into the grass plant. Like other turfgrass scale insects, they lose antennae and legs, while oozing out the substance that soon becomes their clam-shaped shell. The bermudagrass scale can remain attached to the plant for many months before it finally lays eggs and continues the life cycle.

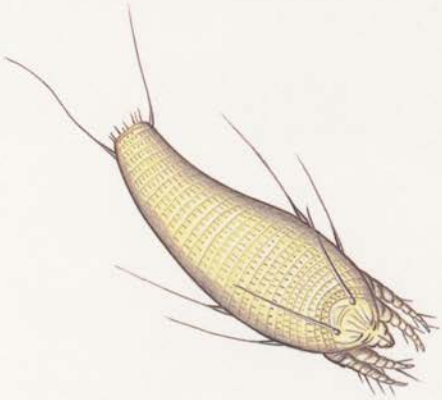
Heavily infested turf takes on a dry appearance and new growth is severely retarded. The turf becomes weakened, thin and susceptible to other problems. Bermudagrass scales thrive in turf that is heavily thatched and do the most damage in heavy shade.

Although not as injurious as the rhodesgrass scale, the bermudagrass scale can drain the vitality from good turf. Its covering serves as a natural protection against predators and makes any form of control particularly difficult.

Bermudagrass Stunt Mite

(Aceria neocynodonis)

Symptoms of bermudagrass stunt mite injury.



Bermudagrass stunt mite (greatly magnified).

The bermudagrass stunt mite* was first reported in Arizona during 1959. This microscopic insect eventually spread across the South and to other bermudagrass areas. Drastic injury occurs on the coarse-bladed bermudas, such as common and Ormond and particularly where the turf is in a state of stress. Since the broadleaf varieties are most often planted in low maintenance areas, such as parks and playgrounds, these places serve as ideal sites for the bermudagrass stunt mite. When watering and fertilization are adequate, mite injury is generally masked.

Searching for the stunt mite without the aid of a microscope or a very strong hand lens is fruitless, and even with these tools experienced guidance is helpful. To recognize the presence of this pest, it is more practical to have a good awareness of injury symptoms. Grass blades in terminal sheaths become lighter in color and soon start to assume a distorted growth habit. Blades become smaller, closer together and pointed upward, fan-like, in what has been called a "witches broom" effect. Plants are tufted and the turf has an uneven, clumpy appearance.

Bermudagrass stunt mites are variable in size, but the largest is no more than 1/125 inch in length. It is creamy white in color, with a worm-like body and two pairs of stubby legs. It is found hidden under the sheath in all stages of the life cycle.

The stunt mite overwinters in this same hiding place, and when warm weather arrives in the spring, it deposits tiny, round transparent eggs. Eggs hatch and the mite passes through several stages before it becomes an adult. The complete life cycle is estimated to be as short as a single week and several generations are produced during a growing season. The insect is easily transported to new turf areas through clippings.

*Two other mites have been recognized as increasing turf problems. The winter grain mite *(Penthaleus major)*, with its black body and orange-red legs, has damaged turf in northern areas during very early spring. The banks grass mite *(Olegonychus reckulla pratensis)*, which has a dark green body, has long been a pest in bluegrass seed fields. In recent years, it has become a pest of St. Augustinegrass in Florida.

Greenbug

(Schizaphis graminum)

Adult greenbug

Greenbugs destroy turf under the canopy of trees

While the greenbug has been acknowledged as a serious problem in cereal grains for many years, it has only recently been recognized as a pest in turf. Infestation has occurred primarily on Kentucky bluegrass lawns of the Midwest. The greenbug is an adaptable inhabitant of all the United States and lower Canada. Since it has such a strong capacity for reaching enormous numbers, there is a continuous potential for widespread infestation.

Greenbugs are members of the aphid family and are better known as pests of roses and ornamentals. The greenbug hatches and becomes active in the cool weather of very early spring. Nature has provided a number of natural predators, such as lady beetles and aphid lions, which feed on the greenbug. But, during some years, cool spring weather will linger much longer than normal. This provides an opportunity for greenbug populations to reach enormous proportions long before natural enemies become active.

In most instances, greenbugs have caused turf injury beneath the canopy of trees and shrubbery. The insect pierces the surface of the grass blade, sucks the juices from the plant and injects its own fluid. This causes a collapse of the cell walls and eventual destruction of the plant.

Many generations of greenbugs occur during the growing season. The pale green nymphs are either winged or wingless. They have prominent black, "bug eyes" and long, black antennae. When mature, they reach a length of approximately $1/16$ inch.

In southern parts of the country, the greenbug can remain active throughout the year and maintain a continuous reproduction process. This tiny insect is easily carried by the wind and migrates for great distances to infest turf in the north.

In the North, females deposit eggs on grass blades during late fall and early winter. Eggs, which are bright green at first and then jet black, over-winter and finally hatch when temperatures moderate in the spring.

Leafhoppers

(Family Cicadellidae)

Leafhopper

With a family of nearly 2,000 species, the leafhopper feeds on many kinds of vegetation throughout the United States and Canada. In most instances, this tiny little insect is treated as little more than a harmless nuisance. But, the leafhopper is extremely damaging to certain vegetables and ornamentals, while also acting as a carrier for several destructive plant virus diseases. Turf injury by the leafhopper is a rarity, but when they are plentiful, they can cause blighting of leaves, discoloration and even permanent injury. The damage is often mistaken for disease or drought.

The leafhopper flits and jumps from place to place in quick, short bursts. Nymphs are wingless and when disturbed they have a peculiar habit of walking sideways, or backwards. Both adults and nymphs feed on grass and other plants by piercing the tissue and sucking the plant juices. As they feed, they have an unusual characteristic, like aphids, of excreting a clear, sticky liquid substance from their abdomen. This is mostly the part of the plant's liquid that the insect cannot assimilate in its body. It is called "honeydew" and can serve as an attractant for many other insects.

Leafhoppers vary in length from 1/8 to 1/4 inch and their slender bodies are triangular, or wedge shaped. Colors are mottled and speckled shades of yellow, green and grayish-brown, but when the insect is in flight, it looks almost white. Females deposit eggs under sheaths, or embed them directly into plant tissue. Eggs hatch in 5 to 12 days and the nymphs become fully grown in slightly more than three weeks. As many as five generations can be produced during each growing season.

If leafhoppers were allowed to multiply without some form of natural control, their numbers would soon be astronomical. Fortunately, birds and other insects feed on the leafhoppers and keep their numbers from growing out of balance.

Rhodesgrass Scale

(Antonina graminis)

Rhodesgrass scale (greatly magnified)

The rhodesgrass scale gets its name from a coarse-textured pasture grass that is widely used in the deep South. It has gradually developed into a special problem on bermudagrass and St. Augustinegrass turf. Rhodesgrass scale is common in Gulf states from Florida to Texas and can be found as far west as California. Its destruction is not dramatic, but left uncontrolled, it can slowly drain away the vitality of good turf.

The rhodesgrass scale covers its body in such a way that the actual insect is seldom seen. This tiny pest measures less than ⅛ inch across its globular body, and its true color is a dark, purplish-brown. But the shape and the color of the body are covered by a white wax-like secretion that looks like tiny tufts of cotton. These tufts are found clustered near the crown of the plant, but on some occasions they cling to the lower nodes, or the axils of low-lying leaves. They appear completely harmless and insignificant in their surroundings. In this stationary position, they pierce the surface of the grass plant and gradually suck away its juices. Cells collapse and the plant ceases to function properly. Turf appears to be suffering from drought and eventually fades to a dull, lifeless brown.

The rhodesgrass scale can remain fixed in a feeding position for many months. Eventually, the female lays a cluster of eggs, which soon hatch into tiny, round nymphs, or "crawlers." "Crawlers" are quite active and for a few short days they move freely about the lower parts of the grass plant. Then they attach themselves to a permanent feeding place and secrete their wax-like covering. Up to five generations of rhodesgrass scales can be produced each year.

Scale insects resist the ravages of wind, rain and high temperatures, but seldom persist in places where winters are extremely cold. Their injury to turf is most severe during extended periods of hot, dry weather.

Nuisance insects

Centipedes, Millipedes

(Class Chilopoda and Diplopoda)

Millipede

Centipede

Centipedes and millipedes are not true insects, but actually very small and unusual animals. Centipedes are long, flattened, wormlike and have one pair of legs on each body segment. They are swift moving and feed mostly on other insects, which they capture with a poisonous sting. The sting can be painful to man and though it is slightly poisonous, it's seldom serious. Millipedes are slow moving pests with two pairs of legs for each body segment. They are generally scavengers with a strong appetite for decaying vegetation, but they can also feed on roots, tubers and fleshy stems. Both pests are usually found in moist places: under rocks; behind rotting bark, and in the soil itself. Although they are not turf pests, occasionally they become quite numerous. The tropical millipede in particular is a big nuisance in Florida lawns.

Chiggers

(Family Trombiculidae)

Chigger

Although these very tiny mites are almost microscopic, they have a capacity for causing a very intense, discomforting irritation to the human body. The irritation is accompanied by prolonged itching, which often leads to more discomfort. Contrary to belief, the chigger does not burrow into the body. Instead, it inserts its mouthparts into the skin, sucks blood until full and then injects an irritating fluid. In most instances, the chigger has been feeding for several hours before its presence is ever detected. The chigger, or red mite, is mostly a pest of areas east of the Rocky Mountains, although it does occur in the Southwest. It is found wherever there is an abundance of vegetation, and can be quite common in all turf. In cooler climates, the chigger can produce 2 or 3 generations per year, while in warmer areas the number is generally increased.

Clover Mites

(Bryobia praetiosa)

Clover mite

This tiny red pest has no particular attraction for grass, but it uses the lawn to prove that it can be an absolute nuisance. Clover mites feed on clover, legumes, fruit trees, vegetables and various agricultural crops. Like other mites, they cause injury by piercing the surface of vegetation and then slowly sucking away the plants' fluids. But, the clover mite isn't always satisfied with the normal process of feeding. During the first warm days of spring, it occasionally appears in the lawn in great numbers and then uses every crack and crevice to enter the home. They often invade in great numbers, and though they can induce pangs of humiliation for the homeowner, they cause no particular harm. In a few days the intrusion has ceased, but occasionally it occurs again in the fall. This tiny red mite is about 1/30 inch in length. In some instances, it can cause temporary and minor injury to grasses.

Digger Wasps, Cicada Killer

(Sphecius speciosus)

Cicada killer

During the heat of July and August, digger wasps start their normal egg-laying process. They find thin, open turf and prepare a place to lay eggs by tunneling 6 to 12 inches into the soil. At the bottom of the tunnel there are branching tunnels and cells. When many wasps burrow into the soil, they cause turf areas to be blighted with a series of unsightly muddy mounds. One of the most common digger wasps is the cicada killer. It's an unfortunate name with ominous overtones. The cicada killer preys on cicadas, cutworms and a host of other pests. It captures the noisy cicada, stings it and pulls it into the newly built tunnel. At the same time it lays an egg, and the larva, which hatches in a few short days, uses the prey as its only source of food. Digger wasps are mostly a problem of the eastern states. They are not normally malicious, but can inflict a painful sting when molested.

Earwigs

(Order Dermaptera)

Earwig

Earwigs are quick-moving, little insects that occasionally become quite numerous in lawns. They forage at night and then burrow into the soil to hide during the day. Although earwigs can cause injury to flowers, vegetables and other vegetation, they do practically no harm in turf. But they do use piles of lawn clippings as breeding places and can multiply into great numbers in a very short time. Their slender, reddish-brown bodies are about ¾ inches long and terminate with a pair of menacing, threatening pincer-like forceps. These forceps look like a miniature weapon and though the earwig has a light pinch, it is completely painless and harmless to man. The earwig is quite common in warmer parts of the country.

Fleas

(Family Pulicidae)

The dog flea

As blood-sucking insects, fleas can cause great pain and discomfort, but they are even more despised as carriers of disease. They attract rodents, cats, dogs and many other hosts, including man. The flea's body is flattened from side to side, so that it can easily slip through the hair of an animal. It is equipped with powerful legs that allow it to jump well over a hundred times its own height. As the female flea feeds, she lays eggs and these are scattered wherever the animal walks, lays or shakes. Animal nests or sleeping places can be loaded with fleas and flea eggs, but the eggs can also fall off into the turf. They hatch into tiny larvae which feed on all kinds of organic matter. In a short time, the larvae pupate and turn into adult fleas. Fleas have the ability to survive for many months without food, but eventually they find a new host and the life cycle starts again.

Grasshoppers

(Family Acrididae)

Eastern lubber grasshopper

In warmer areas of the world, the grasshopper or locust is a dreaded destroyer of agricultural crops. Following several seasons of dry weather, grasshopper populations can build to massive numbers. The migrating swarms often darken the skies as these pests literally strip the land of all living vegetation and then move on to greener feeding places. This has seldom been observed in this country, but crop damage from grasshoppers is always a potential problem in some areas of the West. The grasshopper feeds on the tender parts of grass and other plants, but there are generally enough natural predators to keep this insect under control. They can become quite numerous in late summer and fall as the non-flying young start to mature. Grasshoppers are only a nuisance in well kept turf and actual injury is an extreme rarity.

Slugs, Snails

(Phylum Mollusca)

Slug

Snail

These slimy pests are found in cool, moist places and particularly under heavy vegetation. In periods of continuous moisture, they can stray into the lawn, but they are basically harmless in turf. Slugs and snails are nocturnal creatures that feed on the leaves of flowers, shrubs and other vegetation around the lawn. If their numbers grow large enough, they can cause a great deal of injury. Most slugs and snails are slightly more than an inch in length, but in some areas of the country they can stretch to nearly four inches. These two pests are classified as mollusks and not true insects. They enclose their shiny, unsegmented bodies with a slime or mucus, and their watery trails are often apparent on sidewalks or stonework around the house. There is very little apparent difference between these two pests, except for the shell that helps protect the snail.

Sowbugs, Pillbugs

(Order Isopoda)

Sowbug

Pillbug

Sowbugs and pillbugs often become quite numerous under stone walks, boards and other damp hiding places around the lawn. They scurry to hiding places when exposed to the light and are generally suspected of causing all kinds of imaginary problems. Although these insects chew on the roots and ground level parts of shrubs, flowers and other vegetation, they feed primarily on decaying organic matter. Sowbugs and pillbugs are not classified as true insects, but as land loving relatives of crustaceans such as lobsters and crabs. They are about ½ inch in length. The pillbug often rolls up into a ball or "pill" when disturbed. Even though the sowbug and pillbug are found almost everywhere, they are generally considered as no more than a harmless nuisance.

Spittlebugs

(Family Cercopidae)

Spittlebug

This nervous, little insect feeds on clover, legumes, certain vegetables and ornamentals, but it is rarely a problem in turf. When the spittlebug becomes plentiful in turf, the grass is generally competing with an unlimited supply of weeds and clover. The tiny, pink to pale yellow-green nymph is seldom seen, but causes widespread damage. It attaches itself to vegetation and encloses its body in a mass of white foam, or "spittle." It drains the fluid from the plant and remains hidden in the spittle until fully grown. The adult is a sombre colored brownish-gray, with a stubby body that reaches about ¼ inch. Spittlebugs, like leafhoppers, are flitting, quick-jumping insects and in many instances cause severe stunting in crops. There are several species and their activity is widespread, but they are most troublesome from the Midwest through eastern states.

Ticks

(Family Ixodidae and Argasidae)

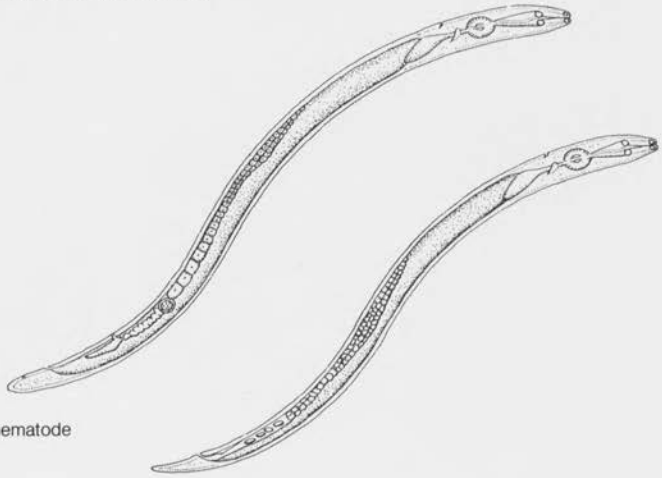
American dog tick

Ticks are leach-like parasitic pests that sometimes become more than a nuisance. They can drain away the vitality and vigor of pets, large and small animals and occasionally man. In addition to their natural blood sucking habits, they are known to be carriers and spreaders of several serious diseases. Most ticks are dull colored, inconspicuous and less then ¼ inch in length. Shortly after hatching, nymphs climb onto vegetation, attach themselves to passing hosts and then evolve through several stages before becoming adults. The adult female feeds until stuffed, or engorged, then drops from the host and lays eggs. In some species, the female is capable of laying up to 6,000 eggs and producing several generations during the year. Ticks are universal in their habitat and with nature's system of checks and balances, they seldom become a problem.

Nematodes

Nematodes

(Phylum Nemathelminthes)



Female nematode

Male nematode

A number of parasites have the capability of causing plant disorders. They include other plants such as mistletoe, various insects, bacteria, viruses, fungi and nematodes. Nematodes thrive in soil, water or plant tissue and they occasionally present a considerable problem in turfgrasses. Injury to turf is caused primarily by nematodes that live in the soil and feed on the root system. But, there are also specific nematodes that prefer crowns, stems and even the seed of growing grass plants. These tiny eel-worms are microscopic in size and a single square foot may contain thousands. Most nematodes cause injury to plant life, but a very few provide a beneficial service by aiding the decomposition of organic material in the soil.

The death of grass plants from excessive infestations of nematodes is a rarity. Instead, nematodes cause debilitating stress as they slowly destroy life's processes and the plants' ability to grow properly. Many times the turf becomes stunted, chlorotic and generally unthrifty. In other instances there is only thinning, or lack of response from the best of care. There are no absolute above-ground symptoms to convey the presence of nematodes. Only a laboratory analysis can determine the extent of nematode infestation and the true potential for turf injury.

Nematodes can cause extensive injury to the root system, but by breaking the root tissue, grasses are exposed to more serious problems. Various diseases caused by soil borne fungi and bacteria can then enter the plants with little natural resistance. Although nematodes live freely in the soil, movement is limited to only a few feet each year. When even the smallest amount of soil is transported from one place to another, new infestations can be the result. The same can happen when excessive rain or irrigation literally floats nematodes to new turf areas.

The name nematode is derived from a word which means "thread-like" and these tiny thread-like pests range from $\frac{1}{70}$th to $\frac{1}{10}$th of an inch in length. They are legless, eel shaped and round in cross section, with

Nematodes do much harm below ground, as they feed on roots and destroy the grass plants ability to function properly.

smooth, unsegmented, nearly transparent bodies. The body cavity contains a fluid through which circulation and respiration take place. The nervous system is extensive and well developed with many unique sensory structures. Reproductive systems are distinct and well developed for both male and female nematodes. All parasitic nematodes have a hollow stylet, or spear, which is used to puncture plant cells. This stylet allows the nematode to feed by withdrawing the liquid within the plant cells. Some nematodes can also inject a fluid into the plant which makes the plant's tissue easier to digest.

Life cycles of most parasitic nematodes are generally quite similar. Eggs hatch into larva and all nematodes have four immature stages. Each stage is terminated by a molt with the first molt occurring while the larva is still inside the egg. The cycle from egg to egg may be completed within three or four weeks.

In terms of habitat, nematodes are either ectoparasitic (feed on cells at the root surface), or endoparasitic (enter the plant roots and feed from within). Examples of ectoparasitic nematodes are: ring, stubby root, and sting. Examples of endoparasitic nematodes are: root-knot; cyst; lesion; lance, and spiral. Of these cyst, lance and spiral are somewhat ectoparasitic during part of their lives.

When heavy infestations of nematodes have been determined by laboratory analysis, only some type of chemical treatment can relieve the problem. Left unattended, nematode populations can increase and turf becomes unmanageable.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